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Neuromuscular Disorders of the Urinary Tract in Children[1]

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NEUROMUSCULAR disease of the urinary tract results from a variety of congenital and acquired conditions. It is usually complicated by infection and obstruction. Because of the lack of clearly defined diagnostic criteria, it is often neglected in differential considerations or is reserved as a final "wastebasket." The importance of the roentgen examination has given the pediatrician and the radiologist the opportunity of being among the first to be in a position to suspect the diagnosis. Examination of several cases at the Childrens Hospital (Denver) in the past few years has stimulated the present review. A few of the cases are reported, with a brief summary of the concepts, in the hope that radiologists especially will contribute more to this subject.

Neuromuscular disease may be congenital or acquired, extrinsic or intrinsic. Among the congenital extrinsic causes are: cerebral palsy, neurovertebral malformations, meningocele, amyotonia, and congenital syphilis. Acquired extrinsic causes include syringomyelia, poliomyelitis, muscular atrophy, cord injury, and cord tumors (1). In most of these conditions the urinary tract is not affected without easily recognized signs of general involvement being apparent. Intrinsic neuromotor disorders may be present without visible congenital defect and without extraurinary signs. They may, however, be found in conjunction with other neuromotor abnormalities, such as megacolon (2, 3), small bowel aganglionosis, regional ileitis (4), or achalasia (5). Cases with involvement of the urinary tract alone are the most difficult to diagnose and treat.

ABNORMAL PHYSIOLOGY

The Ureters: Present concepts indicate that urinary neuromuscular disease involves the bladder primarily and seldom the ureters alone. These are often abnormal from the mechanical and inflammatory effects of bladder dysfunction.

The normal renal pelves partially empty by peristaltic activity every two to three minutes (1). Ureteral peristalsis occurs more frequently. Although this activity will continue after denervation (7) parasympathetic stimulation increases it (the reason for poor urographic results following use of parasympathomimetic drugs). Excessive mechanical dilatation after a time will inhibit peristalsis. Ureteral atony may be considered primary only when complete urological study, often including a long period of observation, reveals no bladder abnormality (8). This is the true megaloureter (9). It shows gaping orifices, absence of peristalsis, dilatation, and reflux on cystography. Tortuosity, which is characteristic of me-

[1] From the Childrens Hospital, Denver, Colo. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5–10, 1954.

chanically obstructed ureters, is minimal (10, 11).

Pathologically, megaloureter may be due to absence of the myenteric (Auerbach's) plexus. Probably the most significant evidence for this condition is the association of megaloureter with megacolon, arguing for a common parasympathetic defect. However, in the normal ureter, unlike the bladder, it is difficult to demonstrate plexuses, which are found only in the lower third and sparsely there (7, 12). This makes histologic proof of any given case impossible so far as the ureter alone is concerned. Ganglia have been found at the ureterovesical juncture consistently enough to give their absence significance. This may be one explanation for megaloureter associated with a normally functioning bladder.

Defective muscular development has been offered as a cause for megaloureter (5). Histologic studies have failed to show more than the amount of thinning to be expected for the amount of dilatation present. Infants often show moderate ureteral dilatation, usually bilateral, which disappears spontaneously after a few months. Mechanically weak musculature may be responsible.

The Bladder: Neuromotor disorders of the bladder are far more common than pure megaloureter. They represent a significant portion of pediatric urology. They are most difficult to distinguish from obstruction of the bladder outlet and urethra. Many kinds of treatment, all somewhat unsatisfactory, have led to further confusion and inaccuracy of clinical data. Even the more clear-cut syndromes such as those resulting from trauma to the cord may be difficult to understand. The less severe dysfunctions may be impossible to classify, since they are almost always complicated by the very processes from which they need to be distinguished—obstruction and infection. Simple classifications are based upon severity of involvement and neurological level. Since severity ranges from extreme to minimal, and since anatomical location is from the brain to the most peripheral neuron in any one or combination of the three (somatic, sympathetic, parasympathetic) systems, a case may be most difficult to fit into a classification. In the past all were designated as "cord bladders"—to the extent that the meaning of the term became completely obscure (8). The following simple classification is of help only in the most gross differentiation, with estimation of severity being a clinically more important factor.

Autonomous: Lesion involving nucleus (reflex center for micturition in sacral cord) and below. No nervous control, no sensation, minimal reflex contractions, large bladders, large residual, small functional capacity.

Reflex: Lesion above sacral center, so that reflex arc is intact. No sensation, periodic reflex emptying, some spastic, some atonic.

Further, when sensory pathways are gone, the completely atonic bladder develops. At the other extreme, the uninhibited bladder is close to normal, lacking only supratentorial inhibition. To further complicate the recognized pathways, a set of parasympathetic fibers connecting the rectosigmoid and bladder is thought to have some tonic effect (13).

Therapeutically, one of the most important considerations, regardless of the level of the lesion, is the amount of residual urine. Parasympathetic interruption leads to atonicity and large residual, but if the ureters are transplanted out of the bladder, it does not become atonic. This indicates that lack of emptying rather than lack of nerve supply is responsible for the atonic bladder. The lack of ability to empty the bladder is essentially a balance between expulsive force and opening of the outlet. As the bladder dilates, the outlet opening decreases while the oblique ureteral orifices become more open. The bladder pressure is then transmitted to the kidneys. Hydronephrosis and renal failure result. Redundant mucosa may fold over the bladder outlet,

further obstructing outflow. In extreme cases the bladder wall may invaginate into the urethra (15).

The spastic bladder, although able to contract, functions no better. It cannot store a necessary amount and soon acts as an obstructed bladder, resulting in ureteral reflux and hydronephrosis. This type is found more rarely than the atonic in the "idiopathic" group.

DIAGNOSIS

When a definite neurological injury, developmental defect, or systemic disease is present, the urinary problem is one of degree of severity and method of treatment. Association of a more easily recognized abnormality such as megacolon is at least presumptive evidence of a similar defect in the urinary tract (about 50 per cent of patients with Hirschsprung's disease will have some urinary dysfunction). The "idiopathic" group must first be separated from plain obstruction and infection. Many cases will have to be classed as indeterminate until after their severity and the results of treatment have been decided. Months of treatment trial may provide the answer. There is no short cut to diagnosis and, although all of the following procedures may contribute information, no one is the deciding factor.

Physical examination is most helpful in ruling out associated disease and defects (clubfoot or sacral dimple are common associated findings in congenital neurologic disorders). In addition to routine neurological survey, special attention should be given to urethral sensation and to anal sphincter tone.

Scout films of the abdomen may show vertebral deformity, kidney enlargement, bladder enlargement, stone, or an unusual gas pattern in the bowel. Mild megacolon may first be suspected from this appearance. Bone structure may show evidence of renal insufficiency.

Cystography, sometimes neglected, may be most valuable. The small, irregular spastic bladder, with the posterior urethra filled, is typical, but is similar to the picture in cystitis. The atonic bladder may be normal in size or may fill half the abdomen. It is smooth and often is associated with funnel dilatation of the posterior urethra due to lack of the internal sphincter. Diverticula or lesser wall irregularities may follow infection. There is usually reflux (a slightly higher percentage of reflux will be found if delayed cystograms are made—16). Reflux often occurs, however, following chronic bladder obstruction, and is seen normally in a few cases, especially during anesthesia (17). Fluoroscopic examination of the bladder may help to estimate bladder contractility, but the dilated neurogenic bladder behaves about the same as the chronically obstructed one. Urethrograms may be useful in showing the condition of the external sphincter, which may be spastic in some neurogenic types. Urethrography is also helpful in ruling out mechanical obstructions such as tight vesical neck, stricture, and rarely valves.

Urograms demonstrate the extent of damage to the upper tract and exclude higher obstruction. Fluoroscopic examination of the ureters may show complete or partial lack of peristalsis, but this may also occur in the obstructed ureter. A localized quiet segment was thought to be comparable to the spastic segment in megacolon, and readily determinable by fluoroscopy. Several of our cases have shown this nicely, but in each instance it has later been found to be due to an overlying band which, when removed, allowed normal peristaltic activity. The typical neurogenic ureter should be evenly dilated, not kinked, and not associated with more than moderate hydronephrosis. The condition may be bilateral but, when so, is much more likely to be associated with bladder dysfunction.

Cystoscopy helps to exclude mechanical obstruction. The bladder wall can be studied and the effects of infection estimated. The atonic bladder is usually dilated, thin-walled, and with little trabeculation. The mechanically obstructed

bladder is usually thick-walled and trabeculated. In the atonic bladder the ureteral orifices are gaping; they may be, also, in the obstructed bladder. Fluoroscopy or rapid serialography may follow retrograde injection (19).

Determination of the residual urine is most important. The radiologist may gain this information by obtaining a pyelogram after voiding. The amount often determines the treatment. A future amplification of this phase of examination is the cystometrogram, obtained by measuring the bladder pressure while adding increments of filling. A simple manometer may be used, but pressure tracings with a recording device may give more information. The value of the procedure is estimated differently by various investigators. It certainly gives some information and may help to differentiate a neurogenic from a non-neurogenic condition, but probably does not locate the neurological level as well as some have suggested. The hypertonic bladder has low capacity, with normal to high pressure (20). The completely atonic bladder has high capacity and initially low pressure, although when filled it may have a high pressure. The reflex bladder may show periodic contractions with a normally increasing pressure, or no contractions until a peak is reached (21). Like many other laboratory procedures, the value of the test seems to be in proportion to its frequency of use in experienced hands with standard conditions. One observer (22) feels that part of the discrepancy in results reported by different authors is due to lack of correlation of ureteral reflux with the cystometrogram. The large volume held by the dilated ureters and kidneys must have some effect on the readings. Our clinic is at present studying this phase of the problem.

Surgical relief of improperly draining ureters and bladder may later prove whether the condition is truly neurogenic. Usually drainage results only in improvement of the secondary obstruction in these cases, having no effect upon the primary disorder.

TREATMENT

There is probably no effective treatment for true megaloureter other than removal of the ureter and its kidney. Intrapsoas displacement to obtain external pressure has apparently been successful in 2 cases (23). Segmental resections and bladder opening transplants have failed. Nephrostomy or ureterostomy may be life-saving in bilateral cases, but of course offers no definitive correction. Most bilateral cases will be found to be of bladder origin.

The treatment of bladder dysfunction depends upon its severity. If the amount of residual urine is large, or if the upper tract is dilated, cystostomy is indicated. Drainage and antibiotics may reduce the manifestations to a point where bladder neck resection may be enough to control the residual. In lesser cases, transurethral resection may suffice. The rationale for this procedure lies in the reduction of the outlet resistance to a point where a weak contracting force will expel the urine, even though the bladder neck may not have been abnormally contracted (7, 23). Training in frequent voiding and use of external pressure may help. Resection of sympathetic trunks has been disappointing. In a few cases, prolonged (months to years) antibiotic therapy without surgery has resulted in remarkable improvement (24).

Frequent re-examination of the upper urinary tract is necessary, regardless of the type of treatment, since progressive pelvic dilatation would indicate direct kidney drainage at any time.

CASE MATERIAL

Thirty-eight cases of megacolon have been examined roentgenographically at Childrens Hospital in the years 1949 through September 1954. Since the urinary tract was not examined routinely in these cases until 1952, cystograms or pyelograms are available in only 14 of the number. In 10 patients the finding indicated neurogenic dysfunction of the bladder. Five of these had urinary tract symptoms. In 2 others such symptoms developed and

abnormal pyelograms were obtained subsequent to corrective surgery for megacolon. No case of megaloureter without bladder abnormality was found in the series.

Eleven cases of severe congenital spinal defects were seen in the same period. Seven showed some degree of bladder dysfunction, some severe. Pyelograms or cystograms have been done for other reasons on 120 patients showing spina bifida occulta. None disclosed neurogenic dysfunction.

In a total series of 2,430 pyelograms and cystograms, a diagnosis of possible primary neurogenic disease of the bladder or ureters was made on the basis of roentgen findings in 35 patients in the same five years. All but 14 of these have been proved beyond reasonable doubt to have mechanical obstructions, and in 3 the diagnosis is indeterminate at this time, leaving 11 probable examples of neurogenic disease. With but one exception these were cases of bladder dysfunction, further showing that primary megaloureter must be rare. Case VIII is presented to illustrate a problem of diagnosis and treatment, possibly a true megaloureter.

The following case summaries and films have been chosen as illustrative. It will be noted that absence of ganglia on microscopic examination is mentioned in some of the reports. This study is being done on all suspected cases, but so far the findings are not on a firm enough basis that any confidence is placed in them so far as the diagnosis is concerned.

CASE I: *Megacolon with Atonic Bladder:* A. M., a 7-year-old boy, was seen at Childrens Hospital with a history of constipation since infancy, but no previous medical attention had been sought. In the six months preceding hospitalization he had experienced several bouts of chills and fever, the last episode being associated with painful urination. He appeared chronically ill and had a distended abdomen, through which large lumps of feces could be felt. The urine showed albumin (20 mg./100 ml.) and innumerable white blood cells. The nonprotein nitrogen was 57 mg./100 ml.

A cystogram showed the bladder to be of moderate size, without trabeculation but with reflux into both ureters, and kidneys which were markedly hydronephrotic. A barium enema study disclosed typical

Fig. 1. Case I: Atonic bladder and ureters, megacolon (cystogram).

megacolon with a spastic rectosigmoid segment. A cystometrogram showed 7 cm. water pressure with the first 50 c.c., 12 cm. with 100 c.c., 17 cm. with 150 c.c., 20 cm. with 200 c.c., and 23 cm. with 300 c.c. Cystoscopy revealed a normal-sized bladder which distended easily and had a thin wall. The bladder outlet appeared normal.

Bilateral ureterostomies were performed and later another cystometrogram showed bladder pressures approximately doubled (35 cm. at 150 c.c. and 40 cm. at 200 c.c.). On the first cystometrogram, reflux occurred after 50 c.c. (Fig. 1). No reflux occurred up to 250 c.c. in the second examination. One year later, the ureterostomies were closed and suprapubic cystostomy was performed. A pyelogram at this time showed marked decrease in the hydronephrosis. The patient has been on cystostomy drainage at home for about three months.

CASE II: *Megacolon with Atonic Bladder:* S. H., now a 10-year-old boy, had a sympathectomy at the age of two for megacolon. His symptoms were not improved, and upon admission he presented the picture of untreated megacolon. He had never experienced urinary difficulty, but several recorded examinations in the past had shown pus cells in the urine. The present admission was for the bowel complaint, but an examination was done for urinary dysfunction as part of the routine megacolon workup. Pyelography showed hydronephrosis and hydroureter. Cystograms revealed an atonic bladder

without ureteral reflux. Practically no ureteral peristalsis was seen fluoroscopically. Cystoscopy was thought to confirm the impression of an atonic bladder. There was no evidence of outlet obstruction. A suprapubic cystostomy was done and is being maintained, with some improvement indicated at the first recheck.

tenderness over the costovertebral angle. She had not been ill otherwise and never had bowel symptoms. There were no neurological symptoms and, except for a palpable lumbosacral arch defect, no physical signs were present. A cystogram (Fig. 3) showed a large bladder with ureteral reflux, but without much hydronephrosis.

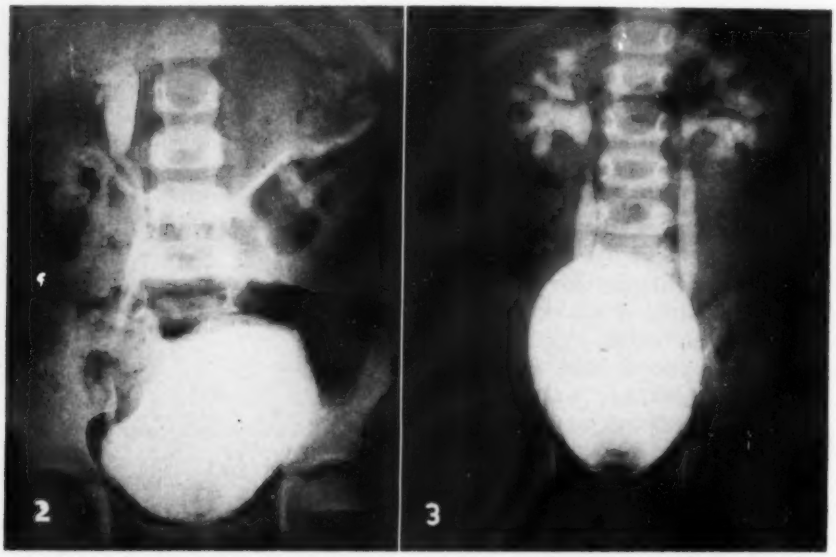

Fig. 2. Case III: Severe renal damage, neurogenic bladder, megacolon (cystogram).
Fig. 3. Case IV: Spina bifida, atonic bladder, reflux, hydronephrosis (cystogram).

CASE III: *Megacolon, Neurogenic Bladder with Extreme Renal Damage:* M. W. was admitted to the hospital at the age of 7 years, in renal failure. He had been seen at the age of eighteen months because of constipation, but a diagnosis of Hirschsprung's disease was not made. He had not been seen again until this admission. There was no specific urinary history, but headaches had been frequent. The blood pressure was 200/190; albumin in the urine averaged 100 mg./100 ml.; non-protein nitrogen averaged 75 mg. A cystogram (Fig. 2) showed atonic bladder with reflux. In the kidneys there was marked evidence of recurrent pyelonephritis. Cystoscopy revealed a bladder with thin walls, poor expulsive force, and a wide neck. Cystostomy drainage was tried and appeared to drain the system well, but the prognosis was considered poor because of the anatomical and chemical evidence of renal damage. The child was readmitted after a few weeks in uremia, with a non-protein nitrogen of 262. He died shortly afterward at home.

CASE IV: *Spina Bifida with Atonic Bladder:* L. B., a 2 1/2-year-old girl, had had recurrent urinary infections since the age of seven months, characterized by spiking fever, albumin and pus, and

Fluoroscopic examination revealed good ureteral peristalsis. On cystoscopy, the bladder wall was found to be thin, without contractions. Ureteral orifices were gaping. The bladder neck was wide open. There was no urethral obstruction. The bladder emptied with external pressure. The patient was dismissed for a trial of continuous bladder drainage.

CASE V: *Spina Bifida, Meningomyelocele, Neurogenic Bladder:* B. D., a 3-year-old-girl, had been operated upon at the age of 3 days for meningomyelocele, in the lumbar area. She was paralyzed below the waistline and had no control over urination or bowel movements, dribbling constantly and at times voiding up to 100 c.c. There were no other urinary complaints. Episodes of respiratory disease had been frequent. Cystoscopy showed a tonic contracted bladder with prominent trabeculae. Cystography (Fig. 4) demonstrated a contracted bladder with reflux and no hydronephrosis. The patient appeared to receive an "aura" when voiding was imminent. Therapy is now centered on voluntary voiding in response to this feeling.

CASE VI: *Primary Atonic Bladder:* C. T. was admitted at 13 months because of frequent cramp-

ing without relation to meals. Voiding had been frequent and in small amounts. The child was small and appeared chronically ill. Physical examination revealed no neurologic abnormality. The anal muscle was normal. The urinary findings were negative, but antibiotics had been given. Films (Fig. 5) showed a dilated, apparently atonic

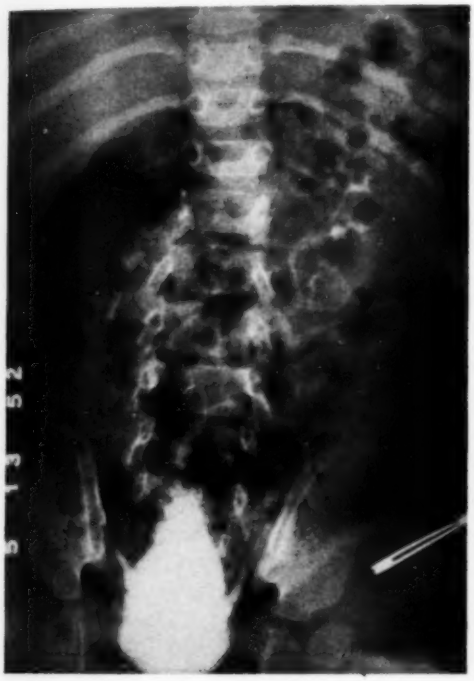

Fig. 4. Case V: Spina bifida, tonic bladder (cystogram).

bladder and dilated lower ureters, but no reflux. Ureteral peristalsis was good. Cystoscopy revealed a thin bladder wall, poor force, normal ureteral orifices, and a normal outlet and urethra. Because of probable poor bladder tone, in spite of a normal appearing neck, bladder neck resection was done. A suprapubic cystostomy was maintained for a short time. The patient has gained weight, cramping has ceased, and the voiding interval is greatly lengthened.

CASE VII: *Primary Neurogenic Bladder:* L. W. was first seen at 14 months of age, having had repeated febrile episodes for four months. The urine had shown infection over the past three months. There were no other complaints. Physical examination was negative. A cystogram (Fig. 6) showed a small trabeculated bladder with reflux, and gross kidney and ureter dilatation. Cystoscopy revealed no bladder outlet obstruction; the ureters appeared freely open. An indwelling catheter was tried without improvement. Exploratory operation showed an atonic but not dilated bladder. The ureters were dilated and adherent, as though mechanically obstructed. They were freed and reimplanted by the Best doubling-back technic. A suprapubic cystostomy tube was left in. Ganglia were reported absent in the bladder in the ureterovesical area.

Fig. 5. Case VI: Primary atonic bladder (cystogram).

Fig. 6. Case VII: Primary neurogenic bladder, hydronephrosis (cystogram).

Fig. 7. Case VIII: Indeterminate. Possible megaloureter (retrograde pyelogram).

A later examination showed improvement in hydronephrosis, indicating that this was secondary to the bladder dysfunction.

CASE VIII: *Indeterminate; Possible Megaloureters:* J. W., a 3-year-old girl, had been in good health until six months previously; since that time she had frequently awakened at night, crying with pain in the abdomen. The urine had been unusually strong smelling. Treatment had been given at home for urinary infection just prior to admission.

The patient appeared normal, and neurological examination showed no abnormalities. The urine continued to contain large amounts of pus. Streptomycin-sensitive colon bacilli were isolated. Cystoscopy showed an inflamed but otherwise normal bladder. Pyelograms (Fig. 7) showed grossly dilated ureters bilaterally, with extreme hydronephrosis, slightly worse on the right. The ureteral dilatations terminated sharply a little below the middle, the lower ureter folding at right angles and being smaller than normal the rest of the way down. Both ureters could be catheterized with ease, and the catheters passed up to the kidneys. Good peristalsis was present in the upper dilated portions; none in the lower narrowed parts. Exploration of the right side was done and the upper ureter was found to be dilated, with a thick wall. A collar-like obstruction was found at the junction of the dilated and narrow portions. This was dissected and the ureter seemed to dilate. No bands or overlying tissue were present. Section at this level revealed no ganglia. The patient did not improve and, after two months, nephrostomy drainage was instituted. The diagnosis remains undecided between bilateral, equal-level primary ureteral strictures and neurogenic ureteral spasm.

SUMMARY

Many of the disorders of the urinary tract in children have some neurogenic basis. Those with definite associated clinical disease present practically no diagnostic problem except for determination of how much of the difficulty is due to the neurological disorder and how much to subsequent infection and obstruction. Treatment is determined by the severity of the dysfunction and by the neurological level. Cases associated with megacolon are more easily detected because of the known association of the two conditions and the similarity of pattern in cases already reported. The remaining group of neurogenic dysfunctions, unassociated with other disease, must be differentiated from the much more numerous mechanical obstructions and associated chronic infections. Cystograms, pyelograms, cystometrograms, and in more difficult cases medical and surgical therapeutic trials, are the basis of differentiation. Familiarity with the problem and especially with the limitations of the diagnostic methods is most essential on the part of all concerned.

This brief review and case presentation is offered to stimulate further interest in this subject especially among radiologists.

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Childrens Hospital
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SUMARIO

Trastornos Neuromusculares del Aparato Urinario en los Niños

Muchos de los desarreglos del aparato urinario en los niños reconocen una base neurógena. Los asociados netamente con una afección clínica apenas si plantean problema de diagnóstico, excepto en lo tocante a determinar qué proporción se debe al trastorno neurológico y qué proporción a la infección y oclusión subsiguientes. El tratamiento se rige por la gravedad de la disfunción y por la participación neurológica. Los casos asociados con megacolon se descubren más fácilmente debido a la conocida asociación de las dos dolencias y la semejanza del patrón presentado por los casos ya descritos. El grupo restante de disfunciones neurógenas, sin asociación con otras enfermedades, tiene que ser diferenciado de las mucho más numerosas oclusiones mecánicas e infecciones crónicas asociadas con éstas. Los cistogramas, pielogramas, cistometrogramas, y en los casos más difíciles, pruebas terapéuticas médicas y quirúrgicas, constituyen la base de la diferenciación. El conocimiento del problema y en particular de las limitaciones de los métodos de diagnóstico, es absolutamente de rigor.

Ofrécese esta breve reseña y presentación de casos para avivar más el interés en este tema, sobre todo entre los radiólogos.

Spinal Osteomyelitis Associated with Urinary Tract Infections[1]

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THIS COMMUNICATION is concerned primarily with the relationship between urinary tract infection and osteomyelitis of the spine. This association has been realized for a number of years and sporadically described, mostly in the form of case reports.

In 1940, Batson (2) published a classic anatomic study in which he proved the presence of numerous intercommunications between the veins of the pelvic organs and those of the vertebral column. He postulated that, by means of these channels, tumors and abscesses of the pelvic organs may spread directly to the spine, by-passing the caval system. Since the publication of Batson's paper, an increasing number of articles have appeared (1, 3, 4–13).

We are presenting here 9 cases in which spinal osteomyelitis followed one or more bouts of urinary tract infection.

CASE REPORTS

CASE I: J.W.C., white male, age 74. In October 1950, this patient had a transurethral resection for benign prostatic hypertrophy. During 1951, he was seen repeatedly because of urinary infections and retention. Urine cultures grew *Proteus*. Following drainage of a periurethral abscess and a suprapubic cystotomy on Aug. 27, 1951, severe pain developed in the lower back and hips, persisting over a period of weeks.

Roentgenograms of the lumbar spine on Oct. 1, 1951, revealed an osteomyelitis at the L5-S1 level (Fig. 1). Antibiotic therapy was instituted. Subsequent film studies showed further destruction.

In May 1952, heart failure developed and the patient died at home. An autopsy was not performed.

CASE II: G.L.M., white male, age 63. In November 1949, a roentgenogram disclosed a left renal calculus. Early the next month the patient was admitted to the hospital. Following a cystoscopic examination, a severe prostatitis and cystitis developed but responded to penicillin. On Dec. 7, 1949, a transurethral resection was done. During convalescence, mild low back pain occurred, different from the earlier flank pain; this continued through the hospital stay.

Fig. 1. Case I. Roentgenogram made Oct. 1, 1951, one month after onset of back pain. The lesions in the bodies of L5 and S1 are minimal in extent.

On Jan. 10, 1950, the renal calculus was removed. During convalescence from this operation, the patient began to experience back pain at a higher level in the dorsal region, radiating forward around the chest wall. On March 12, 1950, because of the persistent back pain, he was readmitted to the hospital. Roentgenograms at this time revealed inflammatory lesions in the spine at the L1-2 and D7-8 levels (Fig. 2, a and b).

A needle aspiration of the lumbar lesion was done (Fig. 2, c and d), and culture of the aspirated material grew *Pseudomonas*. A second aspiration was unsuccessful in obtaining material.

The osteomyelitis was treated vigorously with antibiotics and healed slowly.

CASE III: E.A.C., white male, age 53, was admitted to the hospital on April 13, 1954, with a

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[1] From the Departments of Radiology and Surgery, Emory University School of Medicine, Atlanta, Ga. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5–10, 1954.

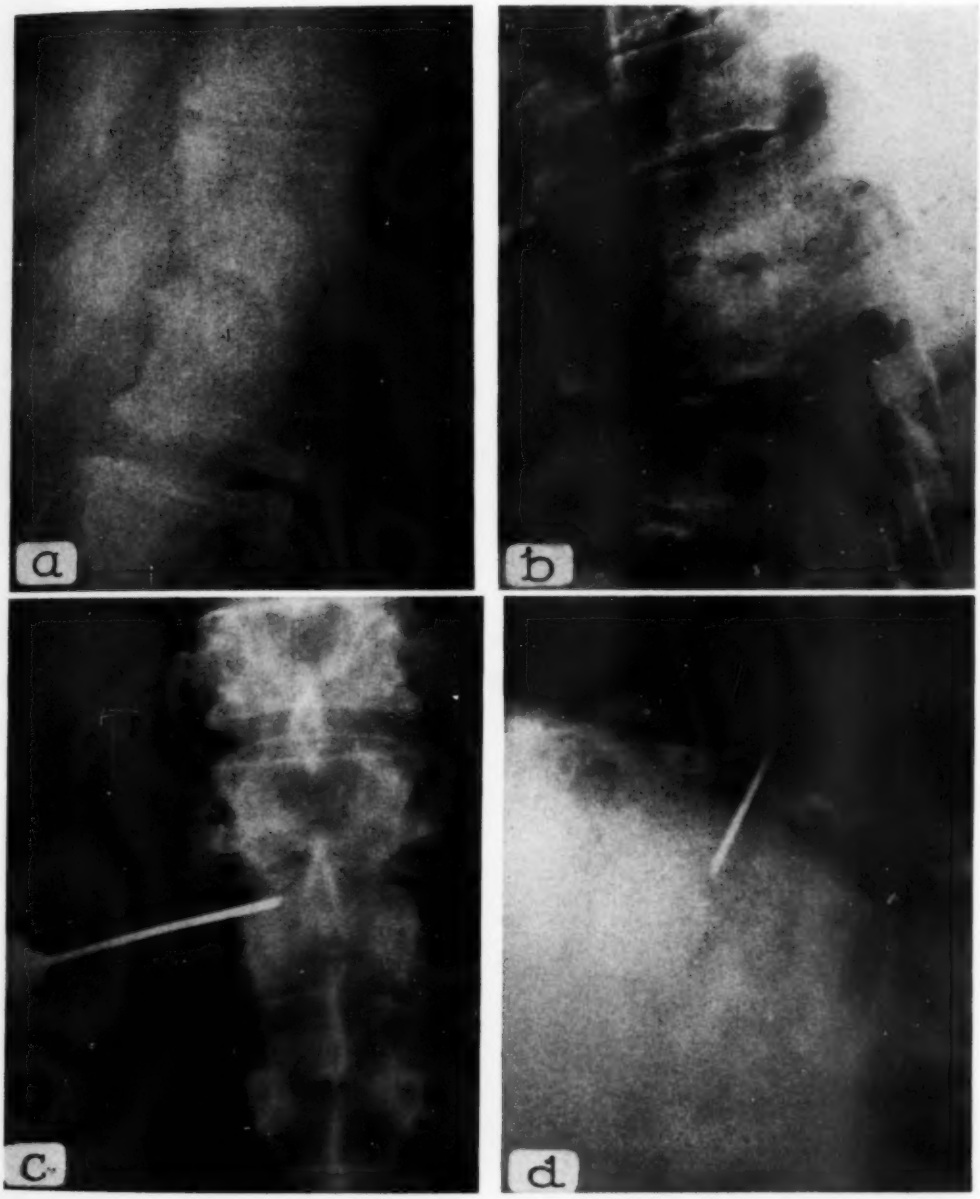

Fig. 2. Case II. Roentgenogram made March 12, 1950, showing osteomyelitis at the L1-2 (a) and D7-8 (b) levels. Aspiration was carried out, using a Biers 15-gauge spinal needle (c and d).

four-month history of progressive interscapular pain, constant in nature and greatly exaggerated by movement. There was a past history of gonorrhea, which had resulted in urethral stricture. Cystoscopy and retrograde pyelograms during the present admission revealed multiple urethral strictures, cystitis, and pyelonephritis.

Routine roentgenograms and tomograms of the dorsal spine on April 15, 1954, showed a destructive process at the D7-8 level, with resultant angulated kyphosis (Fig. 3a). Cultures from a needle aspiration of this area (Fig. 3b) grew *Proteus vulgaris*. Antibiotic therapy was instituted.

On April 22, 1954, the lesion was curetted and the

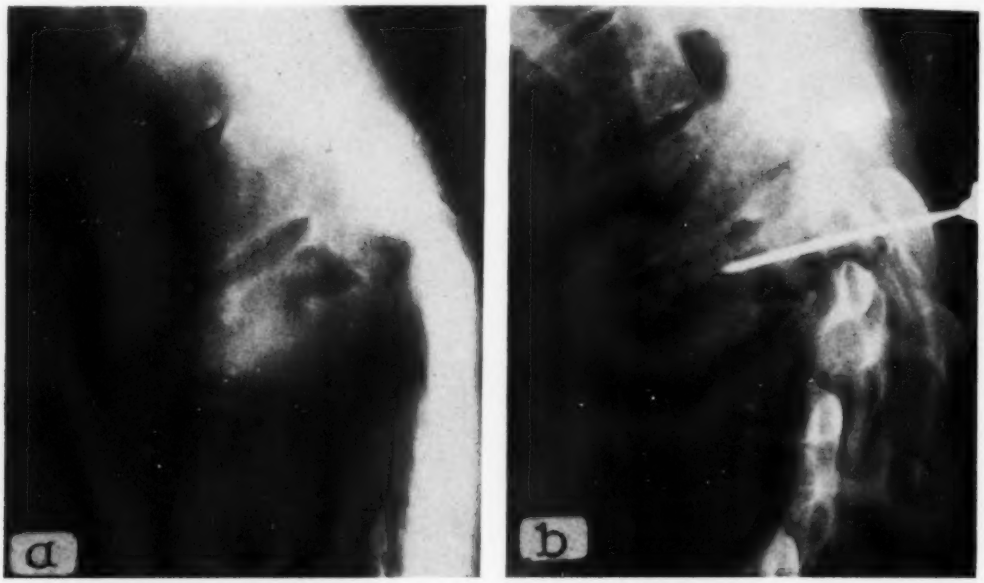

Fig. 3. Case III. A tomogram (a) of the lesion reveals the severe destruction and angulation of the spine. Cultures of aspirated material (b) grew *Proteus vulgaris*.

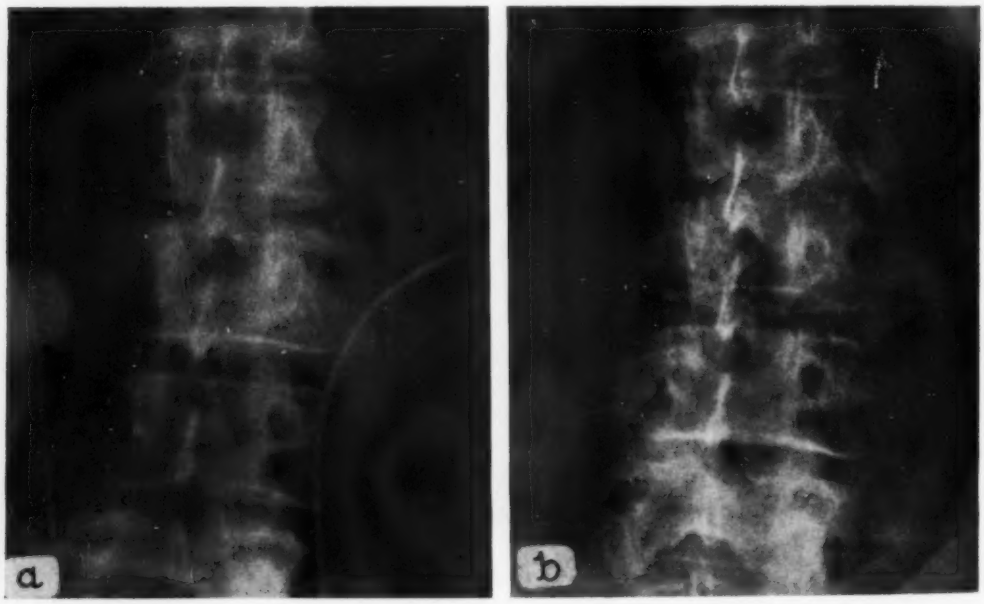

Fig. 4. Case IV. a. Detail of a roentgenogram made during cystoscopy on June 8, 1953. No spinal lesion is present. b. The same area on July 14, 1953, after onset of back pain. An inflammatory process is now present at L2-3.

spine was grafted. On May 8, a body cast was applied for immobilization and relief of pain.

CASE IV: D.M., white female, age 54, was admitted to the hospital on June 8, 1953, with symptoms and signs of urinary tract infection. Cystoscopy revealed a hyperemic bladder mucosa; retrograde pyelograms were essentially negative

(Fig. 4a). Following cystoscopy the temperature spiked daily to 101° F., throughout the hospital stay. The infection was treated with streptomycin, penicillin, and triple sulfas.

Following discharge from the hospital, back pain developed, and the patient was readmitted July 14, 1953. Films revealed an inflammatory process at the L2-3 level (Fig. 4b). Treatment with antibiotics and a back brace was followed by an uneventful recovery.

Fig. 5. Case V. Lateral dorsal spine, Jan. 3, 1951. The tip of the aspiration needle is in the lower part of the involved area. Cultures of the material grew *E. coli*.

CASE V: M.P.F., white female, age 58, had several bouts of urinary tract infection during 1950. On Sept. 9 of that year she experienced severe pain below the right scapula which lasted five days. Roentgenograms of the dorsal spine were essentially normal. On Oct. 15 there was severe pain below the left scapula. This back pain became progressively more severe.

On Jan. 3, 1951, the patient was admitted to the hospital. Films now revealed an osteomyelitis at the D7-8 level. The lesion was needled under roentgenographic guidance (Fig. 5). Cultures of the aspirated material grew *E. coli*. Tests showed sensitivity of the organism to streptomycin and aureomycin. Treatment was begun immediately, and on Jan. 28 the patient was discharged from the hospital greatly improved.

CASE VI: J.W.D., white male, age 49, was admitted to the hospital Feb. 7, 1950, with "distress in the shoulder and chest" of six weeks duration. For the past ten days the pain had been quite severe. He had a long history of kidney stones and urinary tract infections. The last stone was passed at the beginning of the present illness.

Fig. 6. Case VI. Roentgenogram of Feb. 17, 1950, showing osteomyelitis in the mid-dorsal spine.

Roentgenograms made Feb. 17, 1950, revealed a destructive process in the mid-dorsal spine, appearing to be inflammatory in nature (Fig. 6).

Needle aspiration of the lesion was attempted, but cultures produced no organisms. Streptomycin therapy was instituted, and symptomatic improvement was immediate. Subsequent roentgenograms showed progression of the osteomyelitis and then healing.

CASE VII: J.W.O., white female, age 53, was admitted to the hospital on March 26, 1949, with pain in the left renal area, dysuria, chills, fever, nausea, and vomiting. She had had several such episodes during the past year. The temperature on admission was 106° F. Cystoscopy and pyelography revealed a calculus blocking the left kidney, and a congenital absence of the right kidney (Fig. 7a). On April 4, 1949, a left pelviolithotomy and nephrostomy were done. Recovery followed, and the patient was discharged from the hospital.

On Aug. 2, 1949, she was seen as an outpatient, complaining of pain in the lumbar spine and radiations around the flanks into the abdomen. Roentgenograms of the spine showed an inflammatory process at the L1-2 and L2-3 levels (Fig. 7b). Antibiotics were given and a brace was applied. Subsequent films showed progression of the initial

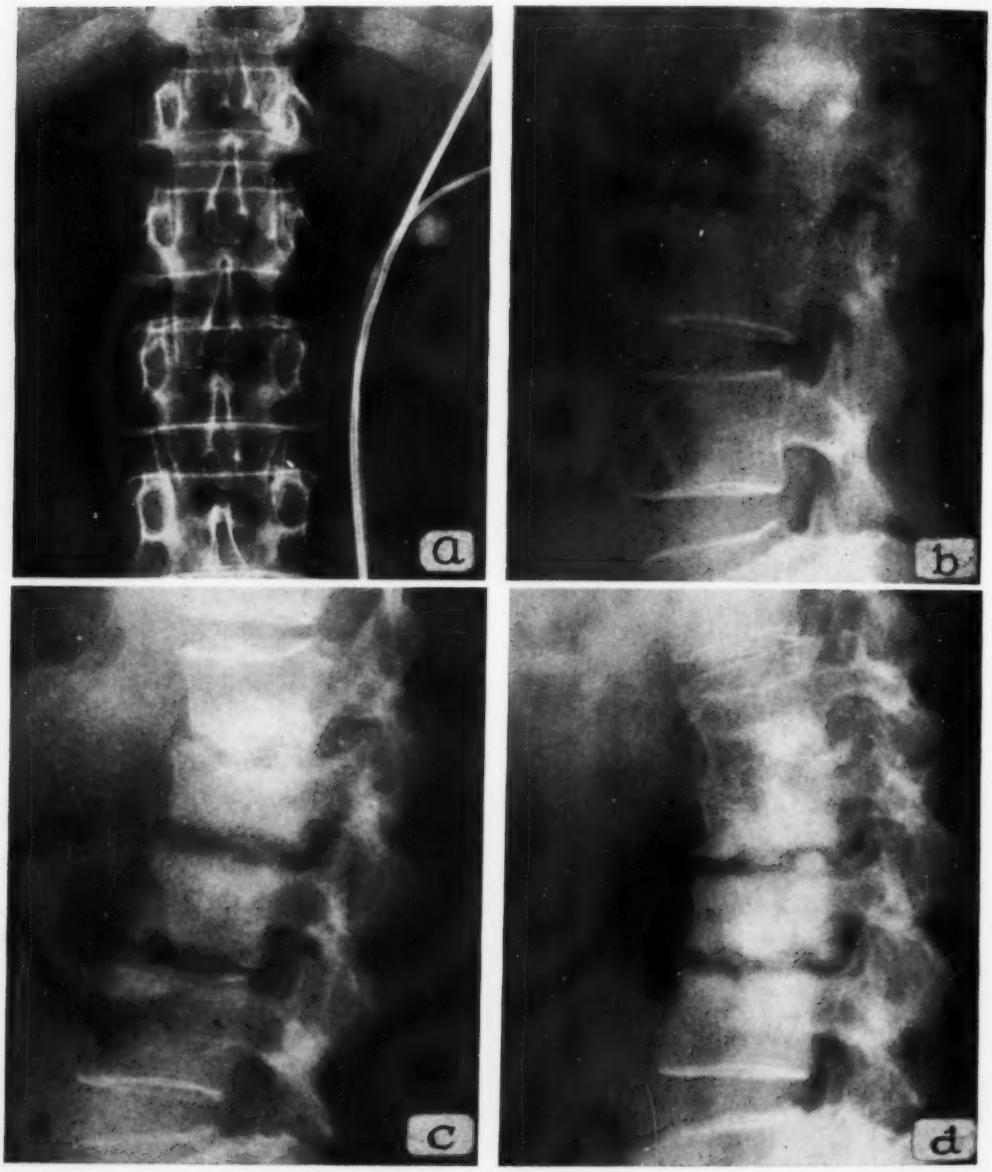

Fig. 7. Case VII. a. Detail of a roentgenogram made during retrograde cystoscopy on March 30, 1949, showing a calculus in the left kidney pelvis. No osteomyelitis is present in the upper lumbar spine. b. A lateral film of the same area four months later, Aug. 2, 1949, now showing an inflammatory process at the L1-2 and L2-3 levels. The patient was then complaining of back pain. c. Further destruction at the same two levels after two more months, with early changes at L3-4. d. Roentgenogram obtained March 1, 1950, eleven months following the urinary infection. Three levels are involved.

lesions and involvement of one additional interspace (Fig. 7, c and d).

CASE VIII: T.S., colored male, age 57, was admitted to the hospital July 10, 1951, with acute urinary retention. He was catheterized with some difficulty and distention was relieved. On subsequent clinic visits urethral dilatation was done. The past history revealed episodes of gonorrhea in 1938 and 1942.

During August 1951, the patient began to have low back pain, and films at that time showed an inflammatory process at the L3-4 level (Fig. 8). Penicillin therapy was instituted. An aspiration of the involved disk space was technically satisfactory, but no organisms grew on culture of the material. On Oct. 16, 1951, a second aspiration was done under direct visualization, and culture of this material grew *Staphylococcus aureus*, coagulase negative.

Subsequently the patient was treated vigorously, but recovery was slow. Films in 1953 and 1954 showed healing of the osteomyelitis.

CASE IX: J.C., white male, age 60, had a twelve-year history of spastic paralysis of unknown cause and repeated urinary tract infections. A trans-urethral resection was done on one occasion following an acute urinary retention. In January 1950, the patient was admitted to the hospital because of another urinary tract infection. Excretory urograms at that time showed a mild right hydronephrosis. The lumbar spine appeared normal (Fig. 9a). Urine cultures produced *Proteus*.

During the summer of 1950, the bouts of infection were accompanied by backaches. On Oct. 27, 1950, lumbar spine films showed a destructive lesion at the L3-4 level, interpreted as osteomyelitis (Fig. 9b).

Subsequently, despite therapy, the course was progressively downhill, with death in uremia.

Fig. 8. Case VIII. Lateral view of the lumbar spine made in August 1951, shortly after the onset of low back pain, showing a well developed area of osteomyelitis.

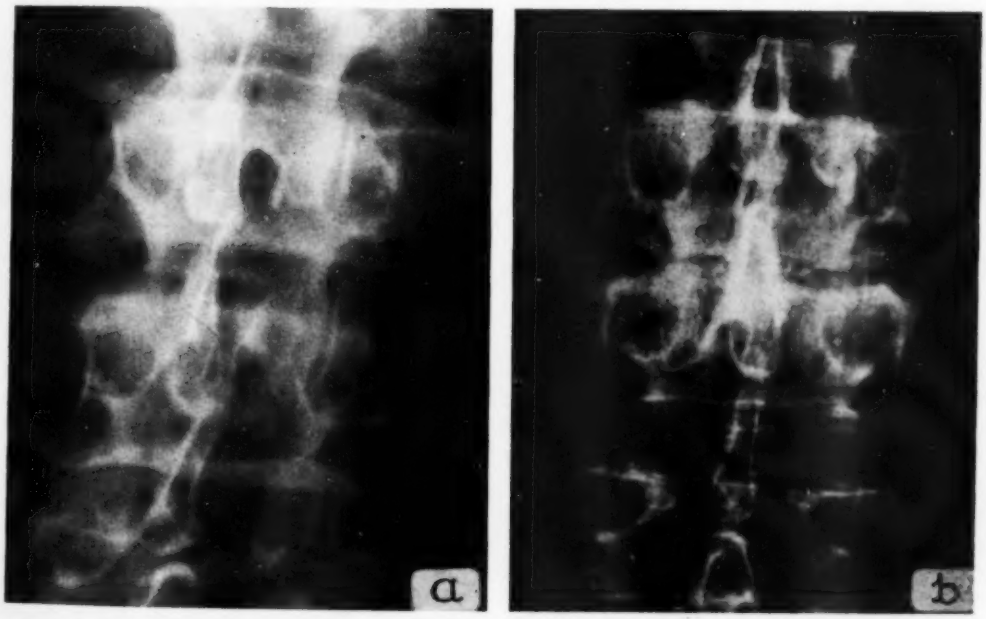

Fig. 9. Case IX. a. Detail of an abdominal film made during excretory urography on Jan. 17, 1950. No osteomyelitis is apparent. b. The same area on Oct. 27, 1950, several months after the onset of back pain, while the urinary infections were continuing. Osteomyelitis at L3-4 is evident.

Fig. 10. Left femoral venogram. The inferior vena cava is obstructed. The injected contrast substance is shunted into the vertebral venous plexus.

DISCUSSION

Batson, in the study referred to above, demonstrated that there exist under physiologic conditions broad communications between the venous plexus of the pelvic organs and the venous plexus enclosing the spinal cord and surrounding the spinal column. The vertebral plexus, which consists of a network of valveless blood vessels, has numerous communications with the veins of the body cavities at various intervertebral levels. The anatomic appearance and relationships of this plexus were shown in cadaver studies. In the living animal, contrast injection of the pelvic plexus would usually result in opacification of the inferior vena cava. However, in the presence of abdominal compression, blood was observed to enter the vertebral venous plexus with great regularity. It is readily apparent that deviation of the venous blood stream into the vertebral channels may occur during life in the presence of many near-physiologic maneuvers such as straining, coughing, sneezing, and perhaps even abdominal distention. Batson therefore postulated that the bizarre spread of carcinoma of the prostate could be readily explained by the general distribution of this venous plexus. Similarly, the spread of paradoxical metastases, as well as the propagation of inflammatory processes, may be attributed to a preferential blood flow through the vertebral venous pathways.

The presence of such vertebral channels collateral to the inferior vena caval system has been demonstrated in the living patient in whom inferior vena cava ligation has been carried out for the prevention of thrombo-embolism or in whom vena cava obstruction has occurred due to neoplastic disease (14) (Fig. 10).

It appears that the group of gram-negative bacilli plays an important causative role in the development of spinal osteomyelitis subsequent to urinary tract infection and instrumentation. In 1929 Scott (11) studied carefully with blood cultures a group of urologic patients who experienced chills and fever during the course of their disease. In 82 patients, positive blood cultures could be obtained. In the great majority of these, gram-negative bacilli were cultured. Scott stated that "blood stream invasions in urology are more commonly due to the colon group bacillus than any other form of bacteria."

Recently Waisbren and his associates (13) reported a series of patients with bacteremia due to gram-negative bacilli other than *Salmonella*. Among 29 patients there were 10 with *E. coli* infection, 7 with *A. aerogenes* infection, 5 with *Pseudomonas aeruginosa*, and 5 with *Proteus* infection. In consideration of the portal of entry of the blood-stream infection in these 29 patients, the genitourinary tract was believed to be the site of invasion in 24 instances. These observations may readily explain why this particular group of organisms may predominate in the type of osteomyelitis described above.

Organisms were recovered from the vertebral abscesses in 4 of the 9 cases reported in this paper: *Pseudomonas* in Case II, *Proteus vulgaris* in Case III, *E. coli*

in Case V, and *Staphylococcus aureus* in Case VIII. Cultures in Case VI yielded no growth. The importance of identifying the organism is illustrated by Case II; in this case, the *Pseudomonas* organism which was recovered was found sensitive to an antibiotic that the patient had not received, although many others had been used.

Roentgen evidence of a lesion in the spine lags behind the clinical manifestations by a matter of weeks or months. Quite frequently the initial films of the spine, made soon after the onset of the back pain, will show no abnormalities. If such is the case, additional studies should be made every few weeks until the lesion is disclosed.

The radiologist should not be content with roentgenograms of the suspected area only, since experience has shown that multiple levels are commonly involved. Adequate studies of the entire spine should be undertaken when osteomyelitis is discovered at one level. Two lesions may involve remote sections of the spine, and may manifest themselves at different times (Fig. 2).

In order to select a proper therapeutic procedure, an exact identification of the causative organism is a prerequisite. This is best accomplished by aspiration carried out under roentgenographic guidance (Cases II, III, V, VI, VIII). Such a procedure may also serve to differentiate the occasional neoplastic process simulating a vertebral osteomyelitis.

A suggested technic for recovering the organism is as follows: The patient is placed prone on the radiographic table and is anesthetized. An area on the back near the lesion in the spine is cleansed and draped. The skin is punctured with a Biers 15-gauge, 3 1/2-inch stainless steel spinal needle. This needle is directed anteriorly and obliquely inward toward the lesion in the vertebral bodies and disk. Without change in the patient's position, 8 × 10-inch roentgenograms are made in postero-anterior and lateral projections (Figs. 2, 3, and 5). These are immediately processed and studied. Further adjustments of the needle and additional films are made as necessary. Aspiration is done, and the aspirated material is cultured and studied microscopically.

Tomography is an important adjunct to the study of osteomyelitis of the spine. Minimal lesions which are obscure and equivocal on routine roentgenograms may be revealed on tomograms. This applies equally well to those more advanced lesions where overlying structures obscure bony detail (Fig. 3a).

The prognosis of this type of osteomyelitis is in general favorable, inasmuch as the healing tendency is pronounced, and extensive destructive changes are rare. Thus, the complete disintegration of one or several vertebrae, such as is commonly observed in tuberculosis, is not to be expected.

SUMMARY

Nine cases of osteomyelitis of the spine developing during the course of urinary tract infection are reported. The spread of the infection from the genitourinary tract to the spine is discussed in the light of Batson's work demonstrating numerous anastomoses between the venous plexus of the pelvic organs and that of the spinal column.

In the majority of cases of spinal osteomyelitis following urinary tract infection, gram-negative bacteria are found to be the offending agent. By aspiration biopsy the causative organism may be positively identified, aiding greatly in the selection of proper therapeutic procedures. A simple method of aspiration biopsy is outlined.

The clinical and radiologic features of this type of osteomyelitis are briefly described.

NOTE: We are indebted to Doctor Richard Schulz of Marianna, Fla., for Case IV and to Doctor C. Mark Whitehead of LaGrange, Ga., for Case VII of this series.

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SUMARIO

Osteomielitis Raquídea Asociada con Infecciones del Aparato Urinario

Preséntanse 9 casos de osteomielitis de la espina dorsal que aparecieron durante la evolución de infecciones del aparato urinario. Discútese la difusión del aparato urogenital al raquis a la luz de la labor de Batson, que revelara numerosas anastomosis entre el plexo venoso de los órganos pelvianos y el de la columna vertebral.

En la mayoría de los casos de osteomielitis raquídea consecutiva a infección del aparato urinario, se descubre que bacterias gram-negativas constituyen el agente culpable. Por medio de la biopsia de aspiración cabe identificar positivamente el microbio etiológico, ayudando así sobremanera en la selección de los adecuados procedimientos terapéuticos. Se bosqueja un método sencillo para la biopsia de aspiración.

Descríbense brevemente las características clínicas y radiológicas de esta forma de osteomielitis.

Primary Reticulum-Cell Sarcoma of Bone, with Emphasis on Roentgen Aspects[1]

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PRIMARY reticulum-cell sarcoma of bone is a malignant tumor histologically indistinguishable from reticulum-cell sarcoma arising in other regions of the body. It originates at a single site in bone and, when metastasis occurs, it is usually by way of the lymphatics. Pain and swelling are the chief symptoms, and characteristically there is lack of constitutional reaction. The prognosis is relatively good, the five-year survival rate approaching 50 per cent following operation or proper irradiation. The importance of distinguishing between this tumor and other similar, but more malignant, conditions, such as osteogenic sarcoma and Ewing's tumor, is apparent.

Several articles make mention of the roentgen findings in primary reticulum-cell sarcoma of bone, but the only paper in the English or American literature devoted specifically to evaluation of the roentgenologic appearance is that of Sherman and Snyder (1), whose study was based on a review of 17 cases. It seemed, therefore, that further study of this problem in as large a number of cases as possible would be of value. It was thought desirable to determine whether there are certain characteristic roentgen signs of this lesion and, if not, whether there are any suggestive findings. In the final analysis, it would be most important to know whether primary reticulum-cell sarcoma of bone can be recognized unmistakably as a malignant neoplasm and thus distinguished from a benign tumor or an inflammatory process.

BACKGROUND DATA

Oberling (2) in 1928 and Oberling and Raileanu (3) in 1932 were among the first to call attention to the fact that reticulum-cell sarcoma can develop in the reticulo-endothelial tissues of bone. Ewing (4), however, stated that, even prior to this, Kaufman had reported a case of what appears to have been primary reticulum-cell bone sarcoma.

According to Parker and Jackson (5) the diagnosis was first suggested in this country in 1931 (Bone Sarcoma Registry No. 1059). Primary reticulum-cell sarcoma of bone was recognized as a distinct entity in 1939, when Ewing reviewed all the material from the Bone Sarcoma Registry of the American College of Surgeons and assigned it a place in his revised classification of bone tumors. Prior to 1939, it had been erroneously identified as Ewing's tumor, lymphosarcoma, osteogenic sarcoma, Hodgkin's disease, leukosarcoma, or inflammatory changes.

Parker and Jackson, also in 1939, reported the first series of primary reticulum-cell sarcoma of bone, consisting of 17 cases. They pointed out that, whereas generalized reticulum-cell sarcoma (a type of malignant lymphoma usually affecting the lymph nodes and spleen predominantly) is a disease of middle and old age, the form which is primary in bone occurs in a younger age group. In their only reference to the roentgen findings, they stated that the appearance was nonspecific.

In 1940, Edwards (6) reported a case of primary reticulum-cell sarcoma of the spinal column. Two cases were published by Szutu and Hsieh (7) in 1942 and 5 by Khanolkar (8) in 1948.

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[1] Abridgment of the thesis submitted by Dr. Wilson to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Radiology. Accepted for publication in September 1954.

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Sherman and Snyder, in 1947, analyzing the roentgenograms of 17 cases seen at the Memorial Hospital, New York City, concluded that there was "a significant similarity in many cases of primary reticulum-cell sarcoma," and added: "in certain instances we believe the appearance can be fairly characteristic."

Coley, Higinbotham, and Groesbeck (9) published a study of 37 cases in 1950. In 1951, 2 additional cases appeared in the literature, 1 presented by Blake and co-workers (10) and the other by Johnson (11). McCormack *et al.* (12) reported a series of 32 cases from the Mayo Clinic in 1952. Ivins and Dahlin (13) added 17 cases to these in 1953. No specific effort was made to evaluate the roentgen findings, but the general impression was that they were indeterminate.

Lichtenstein (14), in his text on bone tumors, classified primary reticulum-cell sarcoma with the malignant tumors of hematopoietic origin.

In 1952, Valls, Muscolo and Schajowicz (15) described 10 cases seen at the University of Buenos Aires. Strange and de Lorimier (16), in 1954, reported 3 cases primary in the skull, these being the only examples in the literature originating in this site.

MATERIAL FOR THIS STUDY

Dr. D. C. Dahlin and others have recently reviewed pathologic material from all the bone tumors treated surgically or subjected to biopsy at the Mayo Clinic through 1952. In this sizable group, they discovered 49 cases of primary reticulum-cell sarcoma. Roentgenograms were available in 33 cases, and these constitute the basis of our study. No case is included in which there is any doubt as to the correct pathologic diagnosis.

PATHOLOGIC CHARACTERISTICS

On gross examination, the tumor is seen to consist of a fleshy, friable substance which usually has a grayish-pink coloration. Its consistency varies from mushy to rather firm. Areas of necrosis are frequently encountered. The line of demarcation from normal tissue is usually indefinite, and the area of involved bone is often extensive.

The microscopic appearance of primary reticulum-cell sarcoma of bone is essentially the same as that of reticulum-cell sarcoma elsewhere in the body (Fig. 1). The tumor is highly cellular and has a loose vascular stroma of collagen bundles and reticulum fibers which characteristically surrounds groups of cells and, in addition, courses between individual cells. Normal bone marrow and cortex are replaced by the tumor. Non-neoplastic osteoid tissue, when present, is not a product of the reticulum cells but of the stroma.

CLINICAL ASPECTS

Site of the Lesions in the Skeletal System: While reticulum-cell tumors may occur almost anywhere in the skeleton, most of them are found in the tubular bones. The distribution in the present series was as follows:

Site	*Cases*
Mandible	2
Upper extremity	
Scapula	2
Humerus	6
Ulna	2
Rib	1
Vertebral column	
Thoracic	2
Lumbar	1
Pelvis	2
Lower extremity	
Femur	9
Tibia	4
Fibula	1
Bones of ankle and foot	1

In 22 of 33 cases the origin was in long bones, and in 14 of these in the lower extremities. It should be noted that in the generalized form of reticulum-cell sarcoma involvement of long bones is uncommon. Whereas the skull is a rather frequent site of metastasis in the generalized disease, the 3 cases of Strange and de Lorimier, as stated above, are the only ones reported in which the disease was primary in the skull. Primary lesions in the mandible, however, are not rare.

Both primary and metastatic forms of reticulum-cell sarcoma are seen in the vertebrae and pelvis.

Sex and Age Distribution: Twenty-five of the 33 patients were males. Thus, the male-to-female ratio was approximately 3 to 1.

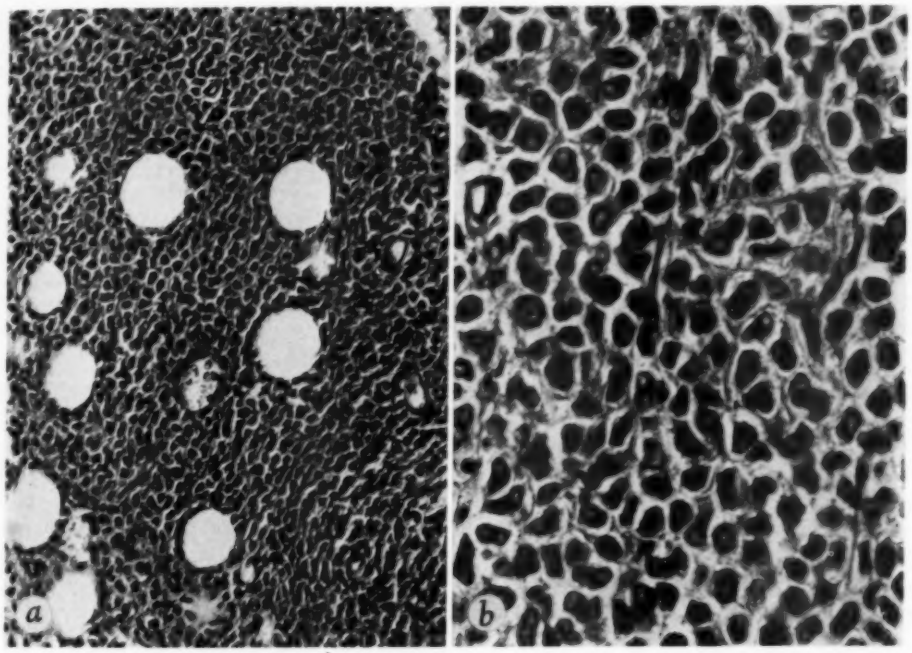

Fig. 1. Microscopic sections showing typical pathologic features of reticulum-cell sarcoma (hematoxylin and eosin). *a*. Tumor invasion of bone marrow. ×200. *b*. Higher-power view demonstrating cellular detail.

The youngest patient was nine years of age and the oldest sixty-seven. The average age of all patients was 39.3 years. Fifty per cent were forty years of age or less; only 4 patients were less than twenty. In comparison, it should be noted that the generalized form of reticulum-cell sarcoma has its peak incidence in the sixth decade of life, and that Ewing's tumor most commonly occurs in childhood and adolescence.

Symptoms: The chief symptoms were persistent pain and swelling, features common to the onset of any malignant bone tumor. Pain was present in all cases and, except in 2, was the initial symptom. Typically, the pain was intermittent at first, gradually becoming more severe, and finally almost constant.

Swelling at the site of the lesion was observed in 85 per cent of the 33 cases. No other notable symptoms were described with the exception of disability resulting from joint involvement by the tumor, or cord symptoms from collapse of a vertebra.

An important feature of the disease which has been emphasized by nearly all writers is the fact that general well-being of the patient is almost uniformly seen. This is in contradistinction to the chronic low-grade fever, fatigability, and loss of weight which are experienced by most patients with other types of malignant bone tumor and by those with the generalized form of reticulum-cell sarcoma. This finding of well-being was noted in the majority of cases in the present series.

Physical Findings: A definite mass, often associated with local edema, was noted on physical examination in 85 per cent of this series. Tenderness in the

TABLE I: FREQUENCY OF OCCURRENCE OF VARIOUS ROENTGENOLOGIC FINDINGS IN 33 CASES OF PRIMARY RETICULUM-CELL SARCOMA OF BONE

Finding	Extent of Change (cases)				Total Positive Findings (per cent of cases)
	Marked	Moderate	Minimal	None	
Destruction of bone	13	12	8	0	100
Reactive proliferation of bone	1	6	8	18	45
Cortical destruction	8	11	11	3	91
Cortical thickening	0	5	4	24	27
Periosteal reaction	1	6	8	18	45
Soft-tissue involvement	13	6	6	8	76
Soft-tissue calcification	0	1	4	28	15

region of the tumor was recorded in 58 per cent. Limitation of motion was apparent in 33 per cent. In 24 per cent, local heat was observed. Only 2 patients, both with infected, draining lesions, had significantly elevated oral temperatures.

Blood Studies: No significant deviation from usual values were found in the majority of patients.

Treatment: These tumors were handled throughout the years (from 1920 through 1952) by various methods. Surgery, roentgen therapy, and radium were used alone and in various combinations. The overall five-year survival rate among those patients followed five or more years was 42 per cent. Approximately half of the patients were treated primarily by amputation, the other half being given irradiation as the basic treatment. There was no statistically significant difference in the survival rates for these two types of therapy.

ROENTGEN APPEARANCE

In order to obtain as accurate an evaluation as possible of the roentgen findings in primary reticulum-cell sarcoma, each roentgenogram was critically studied with regard to the following fundamental features: (*a*) location of the tumor in the involved bone, (*b*) destruction of bone, (*c*) reactive proliferation of bone, (*d*) cortical destruction, (*e*) cortical thickening, (*f*) periosteal reaction, (*g*) soft-tissue involvement, (*h*) soft-tissue calcification and (*i*) pathologic fracture. The extent to which each of the above changes (*b* through *h*) appeared on the roentgenograms was determined and expressed in one of the following terms: marked, moderate, minimal, or none (Table I).

The roentgenologic features are illustrated in Figures 2–8.

Location of the Tumor in the Involved Bone: The site of the lesion in the skeletal system as a whole has been detailed above. It was noted that 70 per cent of the tumors involved tubular bones.

Since many tumors are thought to have a tendency to occur in certain portions of the long bones (for example, giant-cell tumor in the epiphyseal portion, usually after the epiphysis has united; osteogenic sarcoma near the end of the shaft; Ewing's tumor in the mid-shaft), one might wonder whether or not reticulum-cell sarcoma has a predilection for a certain site. It became apparent upon reviewing the roentgenograms that this tumor may develop anywhere in bone. Of the 22 lesions in long bones, 6 were in the proximal portion and 6 in the distal portion; the remaining 10 involved the shaft primarily.

Roentgenologically the lesions appeared to be very extensive. Twenty-five to 50 per cent of the bone was often affected by the malignant process, and in some cases the entire shaft was involved.

Frequent reference has been made in the literature to the occurrence of malignant bone tumors in the region of the knee. This tendency was noted in those lesions of the present series which involved the lower extremities, that is, only 3 of 15 lower-extremity lesions occurred in the proximal portion of the femur and none in the distal part of the fibula or tibia.

Fig. 2. Roentgenogram showing many of the most frequently observed roentgen features of primary reticulum-cell sarcoma of bone. Note irregular areas of bone destruction, minimal reactive proliferation of bone, cortical destruction, and soft-tissue involvement. (Reproduced with permission from Ivins and Dahlin: J. Bone & Joint Surg. **35-A:** 835–842, October 1953.)

Fig. 3. Roentgenogram of a 9-year-old boy showing marked destruction of the mandible with no evidence of reactive proliferation. Soft-tissue involvement was particularly evident on the original films.

Fig. 4. Periosteal reaction. This patient was treated by amputation through the mid thigh and on pathologic examination the tumor was found to be invading the knee joint.

Fig. 5. Cortical thickening and periosteal reaction in a 43-year-old man. The original roentgen diagnosis was osteomyelitis, but biopsy showed reticulum-cell sarcoma. The patient was alive and well seven years after amputation.

Fig. 6. Marked reactive proliferation of bone and extensive soft-tissue involvement. Note the density of the distal part of the femur as compared with that of the tibia and fibula.

The 6 lesions of the humerus were all located proximally.

Destruction of Bone: Bone destruction is a predominant and constant feature in primary reticulum-cell sarcoma. It was noted to some degree in the roentgenograms of all cases, being classified as marked in 40 per cent, moderate in 36 per cent, and minimal in 24 per cent. The areas of destruction gave the bone a mottled, patchy appearance in many cases. However, in the presence of marked changes, the destruction was often so great that no outline of the bone or cortical shadow could be seen.

Uniformly, diseased bone appeared to blend imperceptibly with normal bone. In no cases were sharp lines of demarcation observed.

Reactive Proliferation of Bone: When it is said that a tumor is characterized by bone production, the implication is that the tumor cells themselves actually lay down the osteoid and form the new bone. In many bone tumors this is not the case. Frequently the tumor may stimulate the normal cells to produce bone. This process is referred to as reactive proliferation and is the type of bone production found in primary reticulum-cell sarcoma.

Forty-five per cent of the roentgenograms had evidence of some degree of reactive proliferation of bone. Only 3 per cent (1 case), however, showed this change to a marked degree. Eighteen per cent had signs of moderate reactive proliferation, and 24 per cent had minimal evidence. In more than half the cases these changes were not observed. Thus this feature, while important, was not seen as frequently nor to as great an extent as bone destruction. In only 15 per cent (5 cases) was reactive proliferation of bone more prominent than bone destruction.

Cortical Bone Destruction: In 91 per cent of the series there were findings of cortical destruction. While nearly constant in occurrence, this was extremely variable in degree. In some cases there were only small, irregular areas of erosion, whereas in others there was complete destruction of large segments of the cortex. Thirty-three per cent of the patients showed minimal changes; in 33 per cent there was moderate and in 24 per cent marked cortical destruction. As might be expected, the more extensive destruction was frequently associated with large soft-tissue masses.

Cortical Thickening: The roentgenograms of 27 per cent of the patients showed definite evidence of cortical thickening. This was never marked. It was of moderate degree in 15 per cent, and of minimal degree in 12 per cent.

Periosteal Reaction: In 45 per cent of the cases periosteal reaction was observed. It was marked in 3 per cent (1 case), moderate in 18 per cent, and minimal in 24 per cent. While this feature was readily apparent, in only slightly more than one-fifth of the cases, including those considered to show "marked" or "moderate" reaction, was its appearance occasionally no-

Fig. 7. Extensive destruction of the tarsal bones and widespread soft-tissue involvement. (Reproduced with permission from Ivins and Dahlin: J. Bone & Joint Surg. **35-A**: 835–842, October 1953.)

Fig. 8. The original roentgenologic diagnosis in this case was Ewing's tumor. Biopsy, however, showed the lesion to be unquestionably a reticulum-cell sarcoma. The patient was alive and well when last heard from, fourteen years after irradiation therapy.

table, in that lamellation and an "onion-skin" effect was in evidence. One case was particularly striking: The roentgen appearance seemed to be identical with what has been regarded as typical of Ewing's tumor.

Soft-tissue Involvement: Roentgen evidence of soft-tissue involvement was positive in 76 per cent of the cases. In 40 per cent the periosseous extent of the tumor was marked, in 18 per cent moderate, and in 18 per cent minimal. In only one-fourth of the cases was there no sign of soft-tissue extension.

Soft-tissue Calcification: Definite soft-tissue calcification was observed in 15 per cent of the series (5 cases, or one fifth of the number in which there was evidence of soft-tissue involvement). In 4 of these cases the extent of involvement was minimal, and in 1 it was moderate.

Pathologic Fractures: In 27 per cent (9 cases) there was evidence of pathologic fracture. In all 3 cases of vertebral involvement there were compression fractures. Two femoral lesions, 3 humeral lesions, and 1 pelvic lesion made up the remainder of the group.

COMMENT

From the above analysis, it is apparent that primary reticulum-cell sarcoma may be located anywhere in a given bone but, when occurring in the lower extremity, is more likely than not to originate near the knee joint. When seen in the upper extremity, the lesion frequently involves the proximal part of the humerus.

On the basis of this series of cases, destruction of bone appears to be the chief roentgen feature. While it may vary considerably in extent, it commonly has an irregular distribution, giving the bone a mottled, patchy appearance. About half the time one may expect to see reactive proliferation of bone, but this

finding rarely overshadows the destructive component. Destruction of cortical bone is a nearly constant feature, but it, too, is extremely variable in degree. Thickening of the cortex is seen in about one-fourth of the cases, but is rarely extensive. Periosteal reaction occurs to a minimal or moderate degree in about half the cases and occasionally is a striking feature. Approximately three-fourths of the patients manifest soft-tissue involvement roentgenographically, and one-fifth of these have evidence of calcific changes in the periosseous component. Pathologic fractures are of frequent occurrence.

While the radiologic findings in this series agree to a considerable extent with those described in the only other sizable group analyzed from a roentgen standpoint, there are two essential points of difference. In Sherman and Snyder's 17 cases there was no evidence of calcification in the periosseous component of the tumor, apart from periosteal reaction. In the present series, calcification occurred in one-fifth of the cases in which there was soft-tissue extension. Sherman and Snyder also reported no evidence of expansion of the cortex or definite cortical thickening. In our series, some degree of cortical thickening was seen in about one-fourth of the cases. There were, however, no localized areas of marked cortical bulging due to intramedullary expansion.

Unfortunately, the roentgen appearance as described above is obviously not specific for primary reticulum-cell sarcoma of bone. Other lesions which may appear much the same are certain kinds of osteogenic sarcoma, Ewing's tumor, and eosinophilic granuloma. Reticulum-cell sarcoma with considerable cortical thickening may strongly resemble chronic osteomyelitis on the roentgenogram. The history is often not helpful in ruling out the latter disease, as the symptoms may have been masked by antibiotic therapy.

It may be said, however, that primary reticulum-cell sarcoma should usually be recognized roentgenologically as a malignant bone tumor. This, then, is the chief value of the roentgenogram in these cases. The definitive diagnosis must rest with the pathologist, and all cases should have the benefit of adequate biopsy before treatment is instituted.

SUMMARY

Primary reticulum-cell sarcoma of bone is a malignant tumor which is characterized by a distinct histopathologic appearance and by a clinical course more benign than that of other malignant bone tumors.

The roentgen features of 33 cases were evaluated. In the usual case there were irregular areas of medullary and cortical bone destruction, a variable amount of reactive proliferation of bone, moderate to absent periosteal reaction and, fairly regularly, a soft-tissue mass. Calcification in the soft tissues was seen in one-fifth of the cases in which there was evidence of periosseous extension. Pathologic fractures occurred in about a fourth of the cases.

It is concluded that, while the roentgenologic appearance of this tumor varies to such an extent that it may not be regarded as characteristic, the radiologist frequently may suspect the diagnosis of reticulum-cell sarcoma and suggest it to the clinician. He must, however, keep in mind the fact that osteogenic sarcoma, Ewing's tumor, eosinophilic granuloma, and chronic osteomyelitis cannot always be excluded with certainty.

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SUMARIO

Sarcoma Retículocelular Primario del Hueso, Recalcando los Aspectos Roentgenológicos

El sarcoma retículocelular primario del hueso es un tumor maligno que se caracteriza por un aspecto histopatológico propio y por una evolución clínica más benigna que la de los otros osteomas malignos.

Justipreciáronse las características roentgenológicas de 33 casos. En el caso habitual, había zonas irregulares de destrucción ósea medular y cortical, una proporción variable de proliferación reactiva del hueso, reacción perióstica que variaba de moderada a nula y, con bastante regularidad, una tumefacción de tejido blando. Observóse calcificación en los tejidos blandos en la quinta parte de los casos en que había signos de difusión periósea. Aproximadamente en la cuarta parte de los casos había fracturas patológicas.

Dedúcese que, aunque el aspecto roentgenológico de este tumor varía a tal punto que no cabe considerarlo como típico, el radiólogo puede frecuentemente sospechar el diagnóstico de sarcoma retículocelular y sugerirlo al clínico. No obstante, debe tener presente el hecho de que no siempre cabe excluir el sarcoma osteógeno, el tumor de Ewing, el granuloma eosinófilo y la osteomielitis crónica.

Ehlers-Danlos Syndrome with Ectopic Bone Formation[1]

ISADORE KATZ, M.D., and KARL STEINER, M.D.

INDIVIDUALS afflicted with the Ehlers-Danlos syndrome exhibit a curious and striking complex of genetic abnormalities affecting the skin and its blood vessels, the joints, and the subcutaneous tissues. The skin can be raised in high folds which, when released, retract spontaneously and more or less completely. There is passive and active hypermobility of the joints, particularly of the fingers and toes. Fragility and friability of the skin and its blood vessels are present and are responsible for hematomas which develop following minor trauma. Trivial injuries also produce gaping skin wounds which heal with difficulty, leaving irregular scars. Small, cyst-like, movable subcutaneous nodules are often observed. These are the classical findings, usually present as a group, representing true instances of the syndrome. Occasional cases will exhibit one or more of a variety of associated abnormalities, among which have been reported clubfoot, dental deformities, lymphangiectatic tumors, acrocyanosis, and mental deficiency. Of unknown cause, the syndrome is frequently dominant hereditary, manifesting itself in infancy and persisting throughout life (13).

In recent years reports of the Ehlers-Danlos syndrome have become quite frequent and several comprehensive reviews have been published (13, 16, 21, 33). This work has appeared almost exclusively in the dermatologic and pediatric literature, while the syndrome has otherwise remained relatively unknown. The dermatologists, Johnson and Falls (13), state: "It seems . . . that the syndrome should have been recognized and emphasized by others. For instance, the orthopedists should have been recording the joint symptoms; the surgeon, the friability of the skin; the roentgenologist, the roentgenologic findings; the pathologist, the tissue changes; the internist, the ecchymoses and hemorrhages; and the geneticists, the familial characteristics." Since roentgen study of the patient whose case history forms the basis for this report revealed the hitherto unrecorded presence of true ectopic bone formation in addition to most of the classical clinical features of the syndrome, and because the initial clue to the nature of a peculiar group of clinical findings was derived from roentgen studies, we feel that this report should be added to the radiologic literature.

CASE REPORT

History: A 38-year-old white male was admitted to the Veterans Administration Hospital, Brooklyn, N. Y., on Feb. 19, 1953, for repair of bilateral inguinal hernia. He knew of no abnormalities suggestive of the Ehlers-Danlos syndrome in members of his family.

Since 1943, the patient had had essential hypertension, with headache and blurred vision. Also in 1943, he had first experienced dull aching pains in the left hip, anteriorly. In April 1944, roentgenograms of the pelvis revealed solid bridges of densely calcified tissue extending from the upper margins of the acetabula to the vicinity of the greater trochanters (Figs. 1–3). Following hospitalization elsewhere, a mass was removed from an area over the left hip (June 17, 1944). Postoperatively, massive hemorrhage occurred in the wound, hematomas had to be removed repeatedly, and severe anemia, necessitating blood transfusions, developed.

Pathological examination of the mass removed from the rectus femoris muscle showed it to be bony hard, shaped like a rib, measuring 10 × 4 × 2 cm. Roentgen examination of the specimen revealed characteristic bone trabeculae with compact cortical and central spongiosal architecture. Microscopically mature lamellar bone was seen. Fibrocartilage cells were present at one extremity. The pathologic diagnosis was "metaplastic ossification."

In November 1944, roentgen studies showed new deposits of calcified material at the operative site in the soft tissues adjacent to the upper margin of the left iliac bone, and similar findings were demonstrated on a film made in December 1946.

Pertinent Physical and Laboratory Findings on Admission: The patient was somewhat obese,

[1] From the Departments of Radiology and Medicine, Veterans Administration Hospital, Brooklyn, N. Y. Accepted for publication in August 1954.

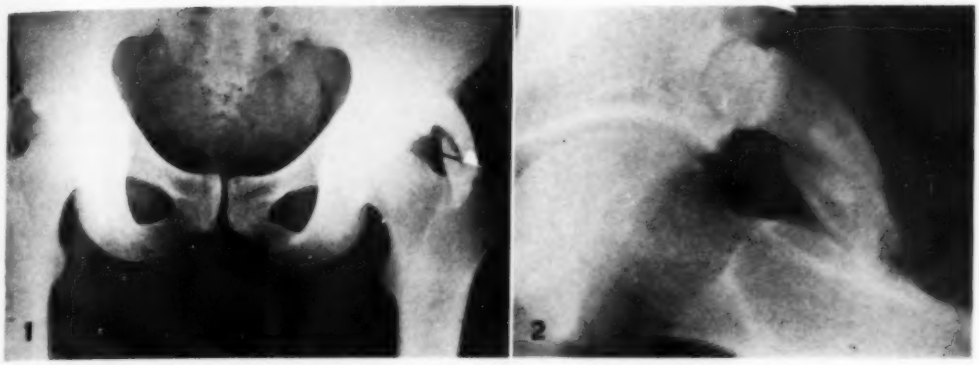

Fig. 1. Original roentgen appearance (1944) of the para-articular ectopic bone "bridges" extending from the anterior inferior iliac spines to the greater trochanter. The mass on the left was excised from its bed in the tendon and muscle fibers of the rectus femoris. Histologic and radiographic examination of the specimen revealed mature bone with compact cortical and internal spongiosal layers. The pathologic diagnosis was "metaplastic ossification."

Fig. 2. Detail preoperative lateral view of ectopic bone in left rectus femoris tendon and muscle fibers. This bony mass measured 10 × 4 × 2 cm. Note radiolucent border at its proximal extremity, resembling joint space. Here fibrocartilage lining cells were found.

Fig. 3. Detail view of original bone mass in the soft tissues around right hip joint.

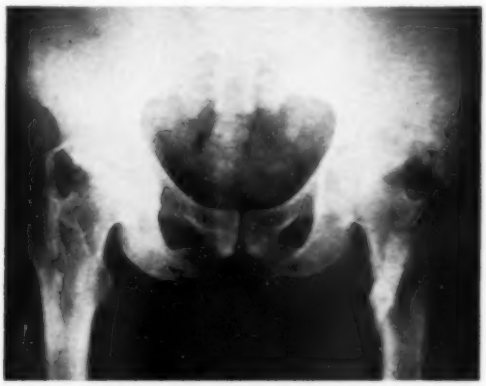

Fig. 4. Appearance of pelvis in 1953, ten years after original roentgenograms (Figs. 1–3). There is a large cauliflower-like calcified mass arising from the original operative site at the anterior inferior iliac spine. This had formed within five months after the original operation in 1944. The right hip, where no operative procedure had been done, remains unchanged during the ten-year period.

with blood pressure of 205/150 mm. Hg. There was a longitudinal scar over the left hip extending into Scarpa's triangle. Over the right tibia some firm, discrete, subcutaneous nodules were palpable. Retinoscopy revealed angiospastic retinopathy, Grade II. Inguinal hernia was present bilaterally.

Laboratory studies, including bleeding and coagulation times, were normal except for blood urea nitrogen values of 25.9 mg. per cent and 24 mg. per cent. Creatinine was 2.4 mg. per cent and 2.3 mg. per cent. The uric acid was 7.9 mg. per cent and 6.67 mg. per cent. Electrocardiograms were suggestive of left ventricular enlargement and myocardial damage.

Roentgen Findings: The chest film showed enlargement of the left ventricular segment of the cardiac shadow and widening of the ascending aorta. Because of the earlier operation for removal of a "bone tumor" from the left hip, x-ray studies of this area as well as of remainder of the skeleton were done. Films of the pelvis revealed a large, irregular,

Fig. 5. Calcified soft tissue nodules in forearms. Best illustrated at the superficial surface of shaft of right ulna.

cauliflower-like calcific mass projecting from the inferolateral aspect of the left iliac bone and another irregular plaque of sclerotic bone overlying the intertrochanteric area of the left femur. Comparison with the x-ray studies made in 1944 and in 1946 indicated that the mass of calcified material in the intertrochanteric area of the left femur had been deposited after 1946. The bony "bridge" across the right hip joint, where there had been no surgical procedure, had remained unchanged in the ten-year interval (Fig. 4).

Roentgenograms of the long bones revealed numerous small, round and ovoid calcified bodies in the subcutaneous tissues of the legs and arms, most numerous in the legs, measuring 2 to 8 mm. (Figs. 5–7). Since the nodular calcified bodies were not situated in the muscles, where parasitic calcifications are usually found, and were too widely distributed (arms and hands, as well as legs) to be ordinary phleboliths, it was felt that they corresponded to those demonstrated by Holt in his paper on the Ehlers-Danlos syndrome (11). On this premise, additional examinations were undertaken.

Special Examinations and Studies: 1. On re-examination of the patient, the most important finding was marked hyperelasticity of the skin (Figs. 8 and 9). In this connection it is of interest that the surgeon had noted, when making the incision for repair of the inguinal hernia, "elasticity of the skin—more so than normal."

2. Distinct hypermobility of the metacarpophalangeal joints was present (Fig. 10). This feature of the syndrome was not very prominent, an observation which has been reported by others (14).

3. Fragility and friability of the blood vessels were manifested by a severe hematoma and extensive ecchymosis which developed in one of the herniorrhaphy wounds on the second postoperative day. It required almost three weeks for this complication to subside. It was recalled that a similar hemorrhagic episode occurred ten years earlier, following the surgical procedure on the left hip.

4. In order to rule out the presence of generalized muscle or nerve disease, based on such conditions as myasthenia, myotonia, or myositis, electrical and mechanical tests for muscle strength and motor nerve function were performed, with negative results.

5. The mecholyl provocative test for pheochromocytoma was negative.

6. Skin biopsy revealed a microscopic picture compatible with cutis hyperelastica (Figs. 11–13). Sections stained with hematoxylin-eosin (Fig. 11) showed some looseness of the pars papillaris of the cutaneous connective tissue. There were no other particular abnormalities in the skin. Connective-tissue stains (Van Gieson's) revealed no tinctorial abnormality of the collagen substance. Elastic tissue stained with orcein revealed a plentiful, and even increased supply of elastic fibrils in all layers of the cutis (Fig. 12).

The ground substance of the connective tissue, stained with toluidine blue and by the periodic acid leukofuchsin procedure (Schiff-MacManus) for polysaccharides and mucopolysaccharides, showed diffuse increase of the latter in some sites (Fig. 13). This increase seemed more marked at the dermo-epidermal junction and in the papillary bodies, where the specifically stained substance presented, figuratively speaking, the appearance of a negative into which the tree-like fibrillar structure of the elastic fibrils could be fitted as a positive. However, no decided abnormality of the ground substance was visible. Treatment of the sections with amylase did not change their appearance, thus excluding the presence of larger amounts of glycogen.

DISCUSSION

Prior to the appearance of the paper by Holt in 1940, the radiologic literature contained no report of the Ehlers-Danlos syn-

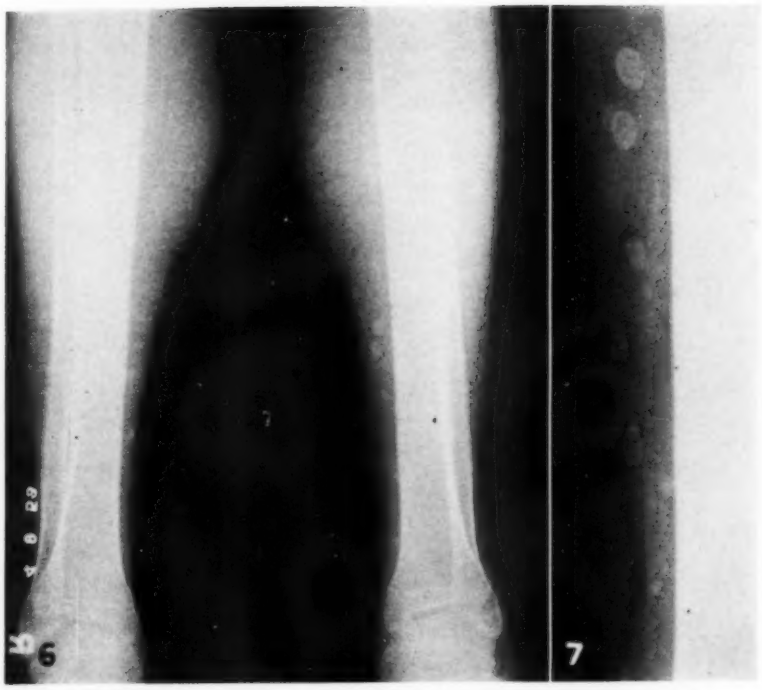

Fig. 6. Calcified soft tissue nodules in legs.
Fig. 7. Detail roentgenogram of calcified subcutaneous nodules over the anteromedial aspect of the lower third of the shaft of the left tibia. This is the characteristic appearance of the nodules in Ehlers-Danlos syndrome. Note the homogeneous internal calcification with the fine, more densely calcified outer "shell." When properly projected, these are always found to be subcutaneous.

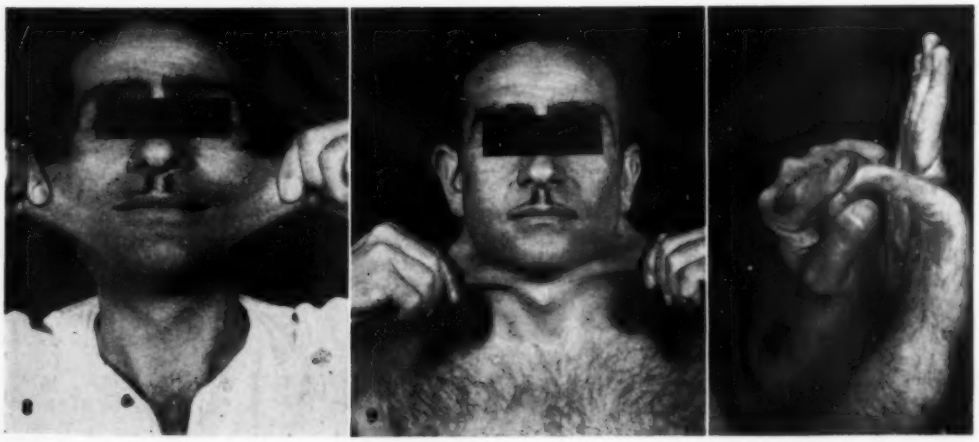

Fig. 8. Hyperelasticity of the skin of the cheeks.
Fig. 9. Hyperelasticity of the skin of the neck.
Fig. 10. Hyperextensibility of joints, illustrated by right fifth finger. Metacarpophalangeal and interphalangeal joints are somewhat hypermobile.

drome. Previous authors had mentioned x-ray studies of their patients and had published roentgenograms illustrating only the bizarre appearance of the joints in hyperextension ("double-jointedness"). Roentgen findings not peculiar to these patients, such as delayed ossification of the cranial bones, retarded closure of the fontanels, delayed epiphyseal development, and osteoporosis, were mentioned in some case reports. More recently Kanof (14) recorded deformity of the metatarsal ends of the phalanges in one case. The current editions of the radiological texts by Caffey (4) and Shanks and Kerley (27) include descriptions or illustrations of the roentgen findings.

The subcutaneous calcified nodules constitute, perhaps, the pathognomonic radiologic finding in the Ehlers-Danlos syndrome. These calcifications were first mentioned as an x-ray finding by Bolam (1). They are widely distributed and are confined to the extremities. They lie close to the surface, immediately beneath the skin, and are most numerous in the lower two-thirds of the legs, tending to be most profuse in the anteromedial (extensor) area, with a fairly symmetrical appearance in both extremities. Hands, feet, scalp, trunk, and the ankle, knee, and elbow joint regions are usually uninvolved.

The appearance of the individual calcifications is distinctive and on close inspection there is little difficulty in differentiating them from phleboliths, with which they are most likely to be confused. Their shape is almost invariably ovoid. The well developed Ehlers-Danlos calcifications, ranging in size from 4 to 8 mm., show a homogeneously dense calcific structure bordered by a sharply defined peripheral zone of more dense calcification, which presents the appearance of a "shell," much like the cortex of a small bony body (Fig. 7). In our patient there were no calcified bodies which exhibited stippling, as reported by Holt. Lamellation of the calcium does not occur. Nodules smaller than 4 mm. tend to be slightly rounded in contour but their overall appearance is the same as that of the larger ones.

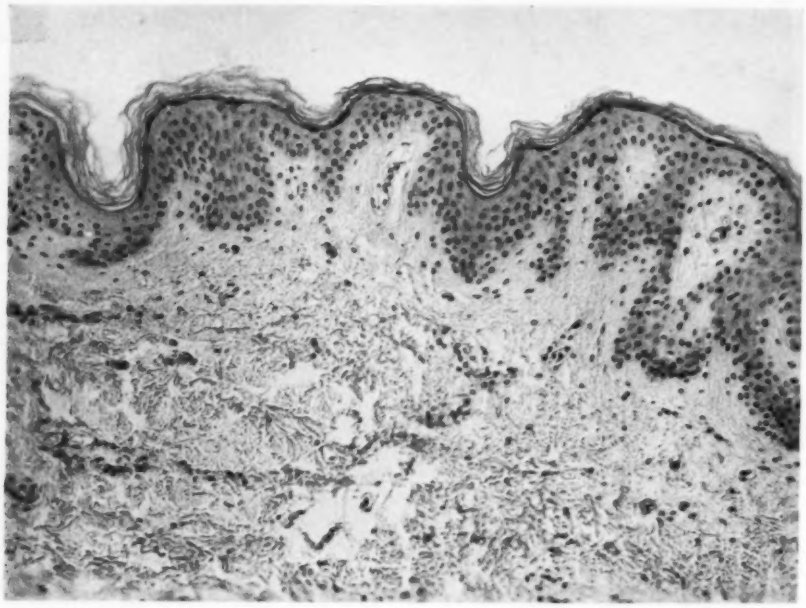

Fig. 11. Looseness of the connective tissue of the pars papillaris cutis. Hematoxylin-eosin. ×100.

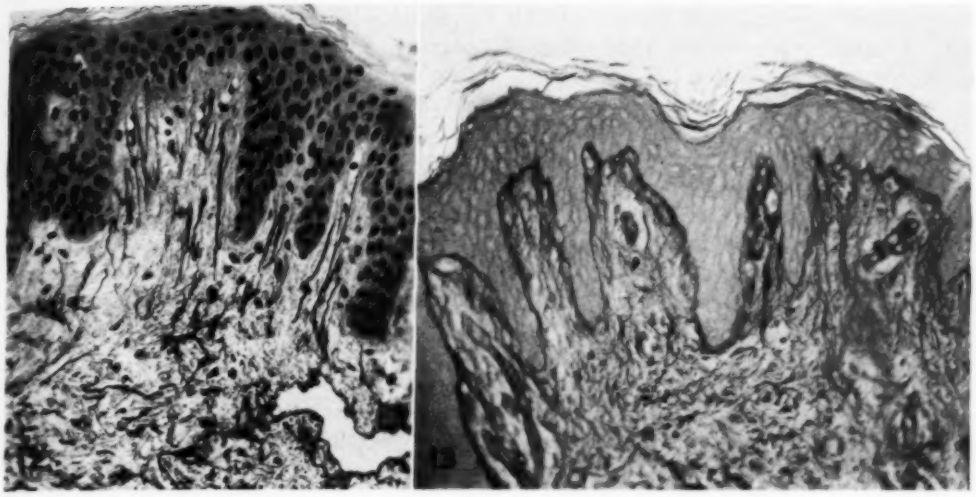

Fig. 12. Patterned, tree-like branching of elastic fibrils in the papillary bodies. Rich supply of normal elastic tissue. Orcein stain. ×145.

Fig. 13. Moderate diffuse increase of mucopolysaccharides, especially at the dermo-epidermal junction. Periodic acid leukofuchsin stain, after Schiff-MacManus. ×145.

Differential Diagnosis: Phleboliths have only a superficial resemblance to the Ehlers-Danlos bodies. Representing thrombi which have become calcified, phleboliths are most frequently seen in the pelvic veins and only rarely in the veins of the extremities. The contour of the average phlebolith is round and lamellated calcium deposits are usually seen. There is no dense outer "shell" of calcium as in the Ehlers-Danlos nodules. Most phleboliths will show a small central radiolucent zone which represents the remains of the lumen of the vein.

Calcified bodies within vascular tumors, such as hemangiomas and angiomas occurring in muscular and cutaneous structures, also differ from the Ehlers-Danlos nodules and resemble the ordinary phlebolith (27).

The calcified larvae of *Cysticercus cellulosae* can hardly be confused with the calcified nodules of the Ehlers-Danlos syndrome. The former are usually flattened, elongated, densely calcified structures, with the ends tending to be pointed. The calcification, while dense, is not homogeneous, and within each deposit there may be observed variations in density. The calcified larvae do not have the characteristic subcutaneous location of the Ehlers-Danlos bodies, being found deep in the muscular tissues (24, 27).

The above constitute virtually all the known types of soft-tissue nodular calcifications from which the Ehler-Danlos bodies need be differentiated.

Pathogenesis of Ectopic Bone and Calcified Nodules: The origin of the subcutaneous calcified nodules has been discussed by many authors (8, 11, 16, 21, 22, 23, 26), but their nature remains controversial. It is safe to say, however, that the type of calcification present in our patient was not metastatic but rather metabolic in character, since there was no diffuse skeletal decalcification and no increase in blood calcium values (15, 40).

Explanation of the finding of heterotopic bone in the soft tissues, not previously reported, presents great difficulty. Radiologically, the resemblance of these ossifications to the para-articular soft-tissue ossifications seen in paraplegic and other patients with disease of the spinal cord is very striking. No satisfactory explanation has been offered to link the development of such heterotopic bone with

the presence of spinal cord disease (10, 31, 32). Among reports of the Ehlers-Danlos syndrome there are only a few instances of associated neurologic abnormalities (12, 19, 28). Our patient showed no evidence of neurologic or muscular disease.

The similarity of the soft-tissue ossifications to those found in myositis ossificans progressiva is suggested by the symmetrical distribution of the lesions in the hip joint areas. Myositis ossificans progressiva, however, is a generalized, progressive, diffuse disease of the connective tissue within muscles, frequently associated with skeletal abnormalities (*e.g.*, microdactylia) and accompanied by definite morbid symptoms such as painful red and tender swellings as well as fever. In our patient, on the contrary, there was no evidence of progression in the ossifications, which were localized and stationary, and relatively few transient local or systemic symptoms were present.

Traumatic myositis ossificans bears some resemblance to the lesions in this case. However, no history of severe injury was elicited, and the bilateral symmetry of the process in the hip areas almost certainly excludes trauma as the principal etiological factor. Furthermore, the ossified lesions of traumatic myositis ossificans usually regress spontaneously after a variable period. Nevertheless, hematomas, providing a matrix for these bone formations, remain an etiologic possibility in view of the known presence of blood vessel friability as manifested by the two episodes of severe hemorrhage, following surgical procedures.

Finally, while it cannot be proved conclusively that these bone formations are not manifestations of some other process or disease, it is felt that there is substantial evidence to account for their manifestation as part of the Ehlers-Danlos syndrome. Normal calcium and phosphorus metabolism and the hamartoma-like, stationary, localized character of these bony processes make their congenital origin probable. Their mesodermal tissue derivation also lends support to their inclusion in the syndrome.

Clinical Findings: The findings in our patient leave little doubt as to the correctness of the diagnosis of the Ehlers-Danlos syndrome. Some of the characteristics of the syndrome were developed only rudimentarily or were absent, *e.g.*, the scars usually found over sites exposed to trauma, such as the pretibial and prepatellar areas. Such scars are the result of ulcerations and wound infection in broken-down hematomas developing in the fragile skin. Of minor importance, because these are found less frequently, was the apparent absence of non-calcified, subcutaneous "spheroids." (The nodules palpated in the pretibial area were presumably only of the calcified type.) The absence of a definite familial or hereditary background is also to be noted.

The patient's hemorrhagic tendencies alone may have provided the initial clue to the presence of the Ehlers-Danlos syndrome. Samuels, Schwartz, and Meister (25) recently reported this syndrome in a young woman who presented hemorrhagic symptoms. Investigation of petechiae occurring in the late months of pregnancy and repeated vaginal bleeding late in the postpartum period led to the recognition of a typical history and physical findings of the Ehlers-Danlos syndrome in this patient (25). These authors stress the point that the syndrome should be included in the differential diagnosis of pseudohemophilia, hereditary familial purpura, and hereditary hemorrhagic telangiectasia.

The finding of essential hypertension in our patient directs attention to abnormal blood pressure findings in pseudoxanthoma elasticum (5, 9, 41), a condition in which there is an actual abnormality of elastic fibres throughout the body, *e.g.*, in the arteries and Bruch's retinochoroidal membrane (5, 7). Thus it appears significant that there is on record a patient who suffered from both the Ehlers-Danlos syndrome and pseudoxanthoma elasticum (5).

Histologic Changes: Tobias (37) and Ormsby and Tobin (17) have suggested

that the connective-tissue changes present in the Ehlers-Danlos syndrome may not be restricted to the skin, but may also be found throughout the body, wherever elastic tissue is present. The microscopic skin findings in our patient indicate that there are structural changes in the elastic tissue and in the ground substance (34). These changes probably constitute the fundamental basis for the skin abnormality

Histologic studies of the skin in patients with the Ehlers-Danlos syndrome are contradictory. Some report an increase in elastic tissue (16, 19, 21, 22, 23, 37), as in our patient; others have found it normal or decreased (2. 18, 39). While the histopathologic skin studies in the case we have reported did not provide a clear-cut explanation of the hyperelasticity—and this is in accord with other studies (2, 18, 19, 21, 30, 37, 39)—it may be worth while to attempt further investigation in future cases.

SUMMARY

Hyperelasticity of the skin, hypermobility of joints, abnormal formation of hematomas, and disseminated calcified subcutaneous nodules constituted the Ehlers-Danlos syndrome, as observed in a 38-year-old white man.

Large masses of mature, ectopic bone were found in the hip muscles, bilaterally. These masses are considered to be a hitherto unobserved feature of the syndrome.

Special stains of skin sections were suggestive of hypertrophic changes of elastic tissue and showed some increase in mucopolysaccharides of the ground substance. A possible systemic distribution of similar changes in other tissues, particularly in blood vessels, may be postulated.

The diagnosis of the syndrome was made roentgenologically by the identification of subcutaneous calcified nodules. It appears advisable, therefore, to consider the Ehlers-Danlos syndrome in instances where roentgen examination discloses subcutaneous calcified nodules and to examine such calcifications critically.

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SUMARIO

Síndrome de Ehlers-Danlos con Osteogenia Ectópica

Preséntase un caso de síndrome de Ehlers-Danlos en un varón de 38 años de edad. El sujeto mostraba las características habituales del síndrome—hiperelasticidad cutánea, hipermovilidad de las articulaciones, formación anormal de hematomas, nódulos subcutáneos calcificados y diseminados—y, además, grandes masas de hueso ectópico maduro en los músculos de las caderas, bilateralmente. Este último hallazgo representa una característica del síndrome, inobservada hasta ahora. No se ofrece ninguna explicación final de la aparición del hueso ectópico, pero se sugiere que los hematomas, que suministran una matriz para esas formaciones, constituyen una posibilidad, en particular vista la presencia de fragilidad de los vasos sanguíneos, traducida en este caso por dos episodios de intensa hemorragia consecutiva a procedimientos quirúrgicos.

Las coloraciones especiales de cortes cutáneos indicaban alteraciones hipertróficas del tejido elástico y mostraban algún aumento de los mucopolisacáridos de la cariolinfa. Cabe presuponer una posible distribución orgánica de alteraciones semejantes en otros tejidos, en particular en los vasos sanguíneos.

El diagnóstico del síndrome se hizo radiológicamente por la identificación de los nódulos subcutáneos calcificados. Por lo tanto, parece acertado considerar el síndrome de Ehlers-Danlos en los casos en que el examen roentgenológico revela subcutáneamente nódulos calcificados y examinar analíticamente esas calcificaciones.

The Roentgen Appearance of Adamantinoma of the Mandible[1]

ROBERT S. SHERMAN, M.D., and HUGH CAUMARTIN, M.D.

IN THE ADULT THE lesion commonly termed adamantinoma is the most frequently encountered mandibular tumor of dental origin. In one series of 119 dental new growths 37 per cent were so classified (11). Considerable investigation regarding the clinical and pathological features has been undertaken (1, 9). Information pertaining to the roentgen appearance is less voluminous and, so far as we can ascertain, no single large series has been studied primarily with a view to establishing diagnostic criteria from this standpoint.

At the Memorial Hospital there are available for analysis 63 cases diagnosed histologically as adamantinoma of the mandible or maxilla. Of this group, 30 were considered suitable for the present study. The basis for the selection was not only a clear-cut and dependable pathological diagnosis, but also the availability of films showing the tumor adequately. While some films were postoperative, none were considered acceptable if they showed any significant distortion of the tumor by previous surgery.

Adamantinoma was described in 1868 by Broca (4), who recognized its relation to the enamel organ. Its origin and pathologic features have subsequently been the subject of numerous studies (10, 13, 16, 23) and need not be considered here. It is generally believed that the tumor is first solid and later becomes cystic from degeneration (18). By the time it comes under observation, it usually presents a multilocular appearance, and it is this feature which has received particular emphasis (12).

The clinical aspects of adamantinoma are well known (1, 2, 3, 6, 8, 13, 16, 17, 22). The tumor is of slow growth and is relatively asymptomatic in its early stages. Actually it is a progressive, invasive, and destructive lesion of low-grade malignancy. Complete removal is curative (5) but recurrence following incomplete excision is frequent (15). Metastases occur occasionally in the cervical lymph nodes, rarely in the lungs.

From a review of the present series of cases, it would appear that the major responsibility for early and dependable recognition rests with the roentgenologist. A characteristic roentgen picture has been denied (6), but it is our opinion that familiarity with the appearance and behavior of the lesion and careful analysis of its roentgen features will in the great majority of instances lead to an accurate diagnosis. This was pointed out by Chont (7), who in 1943 reported 8 cases. He stated that the solid tumors present a "monocystic" appearance, interrupted by small niches on the border of the defect. The "polycystic" type he described as presenting a honeycomb appearance. In general, our findings support his views, but our material is not divided into solid and cystic forms, since we are unable to find any real support from the pathologists for a separation on this basis.

For adequate roentgen demonstration in patients suspected of having a tumor of the mandible we utilize a stereoscopic oblique view and a single postero-anterior projection supplemented by intraoral films of either dental or occlusal type. Except for the intraoral films, the movable grid is used and the exposure is such that individual bone trabeculae are clearly discernible. For accurate interpretation it is occasionally necessary that the roentgenologist be informed as to recent treatment, such as tooth extraction, excision, curettage, or biopsy. In spite of the fact that such information may not be forthcoming, an alertness toward these possi-

[1] From the Department of Diagnostic Roentgenology, Memorial Center for Cancer and Allied Diseases, New York, N. Y. Accepted for publication in August 1954.

Fig. 1. Malignant adamantinoma showing bone destruction and a mass of water density.

bilities will usually permit their recognition by the trained examiner.

ROENTGEN CHARACTERISTICS OF ADAMANTINOMA

In an attempt to establish criteria for the roentgen diagnosis of adamantinoma, a study was first made of 13 tumors for which no operative procedures had been carried out prior to the roentgen examination available for review. With the results of this investigation as a background, a number of other tumors in which some form of surgery had been undertaken prior to our first films were appraised in order to select those in which the operation did not basically alter the x-ray appearance of the adamantinoma. As a result, 16 tumors were added. These represented lesions inadequately operated upon long before and those on which treatment had been limited to incomplete curettage, biopsy, or merely a tooth extraction. The evaluation of the x-ray appearance was based upon a study of the earliest films available. If there were films covering a period of time, the effects of growth and treatment were also noted.

A single malignant adamantinoma was found among the 63 tumors. This occurred in a nineteen-year-old male. The pathologist's report was anaplastic adamantinoma capable of metastasis. There had been no previous treatment. The patient died three months after a resection of a portion of the jaw, but the circumstances leading to death are not known. Roentgenographically there were cortical destruction, an irregular ill defined border, medullary location, an absence of loculation and septation, and a fine patchy productive change in a small soft-tissue mass (Fig. 1). The x-ray appearance was dissimilar to that of adamantinoma as commonly seen and was more consistent with a malignant tumor, such as an osteolytic osteogenic sarcoma, or secondary invasion of bone by cancer or by an epulis.

Location: For the purposes of recording the location of the tumor in the mandible, the bone was divided into three general areas: the ramus, the body, and a third region called the angle. The localization was not intended to be precise and was governed by the area in which the bulk of the mass was situated. Most of the tumors were in the region of the angle. The actual distribution was ramus 0, angle 21, body 8. The site of origin appeared in every instance to be in the medullary portion of the mandible, as might be expected. However, as will be noted later, growth usually extended into the cortex eventually.

All tumors were asymmetrically positioned in regard to the central axis of the jaw bone. Almost invariably they presented superiorly across the alveolus, rather than laterally or medially or inferiorly. Some were so large when first studied that there was total destruction of the mandible (Fig. 2) and the feature of symmetry could not be judged.

Direction of Growth: There appeared to be a clear tendency toward early extension beyond the jaw bone, the tumor breaking through the cortex, with the formation of a soft-tissue mass. In a few instances, however, the growth seemed to remain confined within the bone. In no instance was there any appreciable tendency to extension along the medullary cavity with sparing of the cortex. It is true that a few tumors did not have occlusal film coverage, so that small growth extensions medially or laterally through the cortex may sometimes have escaped recognition.

Configuration: All tumors showed a more or less oval configuration. In judging this feature the entire boundary of the lesion was taken into account, that is, both the part within the bone as well as any soft-tissue extension.

Cortex: The effect upon the cortex of the mandible was threefold: expansion, destruction, and a form of productive change characterized by scalloping. Destruction of the cortex was observed in all but 6 cases. Usually this involved 2 or 3 cm., and in no case was the inferior cortical margin destroyed without the alveolus being similarly affected. In 16 cases some degree of cortical expansion was seen, for the most part of slight degree. When the cortical border was seen at the margin of the adamantinoma, a fine scalloping pattern was regularly formed.

Periosteum: In no case was there evidence of a periosteal reaction radiographically.

Border: The borders of the adamantinoma were found to be distinct on all sides where it was in contact with bone. The fine scalloping along the involved portions of the cortex has been mentioned. The borders along the medullary part of the tumor were also distinct and showed a productive change characterized by a slight band of increased density with a scalloped pattern.

Pathological Fracture: There were no pathological fractures in any of the cases of this series.

Loculations: The most characteristic roentgenographic feature of adamantinoma is the presence of loculations. Twenty-four tumors were multilocular and 5 were classified as monolocular on the basis of the x-ray appearance. Only 1 of the 5, however, presented a complete and unqualified single cavity. One, while it showed a single large cavity, contained a number of tiny septa forming true loculations. Three other tumors also showed some degree of septation within the large loculation, but these were small and incomplete.

In 21 cases there was a central core arrangement of the locules; in other words, the loculations were seen to radiate about a point. The smaller ones were closely grouped at this point, with others becoming larger and fewer in number as they were positioned at increasing distances from the center. The core was generally asymmetrically placed in respect to the overall configuration of the tumor. In the remaining 3 tumors there was a fairly even distribution of the locules.

Fig. 2. Unusually extensive adamantinoma seen at a stage when a number of the helpful x-ray characteristics for the recognition of this tumor have been lost.

The individual sacculations were either spherical or oval. In most tumors both forms were encountered, but in a few instances one or the other seemed to be predominant.

The number of locules varied, in general, from a few to as many as a hundred or more. Most of the series showed from 10 to 100 individual septations. It would seem that adamantinoma usually presents more loculations than other lesions involving the jaw.

Only complete septa, extending from bone margin to bone margin and terminating by bone contact, will form complete loculations. Septa not ending in bone or in other septa will, of course, bring about the formation of partial or incomplete sacculation. In most cases it was not possible to determine this feature reliably. In general it appeared that there were 5

Fig. 3. Typical roentgen appearance of adamantinoma.

tumors where all the septa were incomplete. These included most of the monolocular lesions mentioned above. There were thought to be 4 tumors showing perfect septa formation as evidenced by completeness. In the bulk of the material, some septa were complete and some incomplete.

Actual measurements of the septa were not made, nor did they seem indicated. In a few adamantinomas the partitions were fine, regular, and hair-like. In 2 they were many times thicker. In the remaining cases presenting septation there was an admixture of the fine and the coarser partitions.

Effect on Teeth: In 21 cases no teeth were present by the time of our first radiographic study. In 2 instances where teeth were present, no significant relationship was found, even though the teeth were within the margins of the tumor. In 6, however, the following changes were detected from a study of the radiographs: loss of lamina dura 1, erosion of the tooth apex 4, tooth displacement 2.

Growth Rate: In spite of the fact that many of the tumors were covered by radiographic studies over periods as long as ten years, it was impossible to establish accurately the rate of growth. Because of repeated operations, we were unable to obtain any measurement of the enlargement rate. Some tumors seemed to show very little alteration over a period of a year or more.

Soft-Tissue Mass: In 8 tumors no soft-tissue extension was detected. The extension present in the remaining 21 was compared to the portion of the tumor located within the bone itself. On this basis, it was described as small in 9, moderate in 8, and large in 4.

Summary of Roentgen Characteristics: From the standpoint of roentgen diagnosis, adamantinoma must be divided into two groups, the typical and the atypical. In this material there were 24 typical and 6 atypical tumors, the malignant tumor being grouped as atypical.

The 24 typical adamantinomas were most often located in the body of the mandible at the angle. All seemed to originate within the bone and to be asymmetrically positioned as regards the central axis of the bone. Growth was outward through the cortex, usually on the alveolar side, almost always with cortical destruction of some degree. Some element of cortical expansion was often seen in other areas. The general shape was oval and there was a fairly distinct margin, showing a small band of increased density with more or less scalloping. No periosteal reaction or pathological fracture was encountered. The tumor averaged about 5 cm. in diameter with a range from 2 to 18 cm. when first seen radiographically. Usually a soft-tissue extension or mass was seen, containing more or less well formed striae or septa. In the few tumors in which teeth were present, apical erosions, loss of lamina dura, and displacements were noted. The most characteristic feature was the many loculations. These were of varying size, appearing to radiate outward from a central nest or core. The more peripheral the loculations, the larger they tended to become (Figs. 3–5).

Generally speaking, a reliable roentgen diagnosis in the atypical group would seem to be impossible. The roentgen characteristics of the malignant adamantinoma have been mentioned. Another tumor in the atypical group also warrants special consideration. This is the relatively uncommon form of adamantinoma that is in-

distinguishable radiographically from follicular cyst. In this particular tumor (Fig. 6) a tooth was present within the monolocular cavity in the mandible and our roentgen interpretation was therefore dentigerous cyst. Histologically, however, the diagnosis of adamantinoma was irrefutable. As to the remaining 4 atypical tumors, little specific can be said as to their x-ray appearance. While they presented a more or

Fig. 6. Adamantinoma with atypical x-ray appearance. Unilocular form with a tooth inside the lesion.

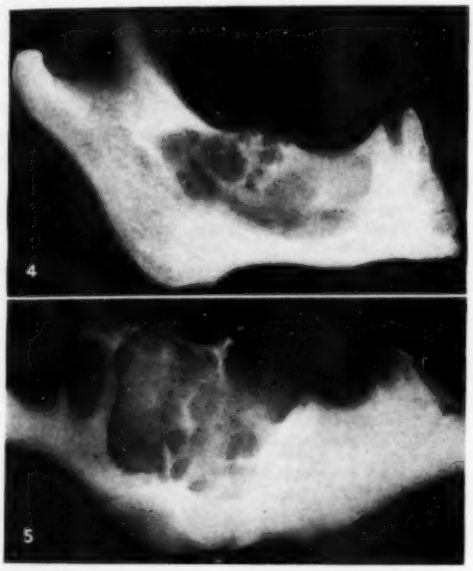

Fig. 4. Typical adamantinoma, showing the central core of smaller loculations.
Fig. 5. More extensive adamantinoma with characteristic x-ray appearance.

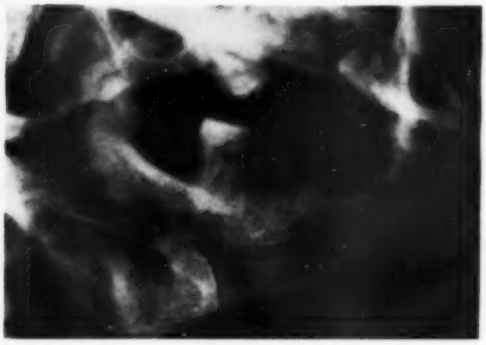

Fig. 7. Atypical adamantinoma showing a saucerized area of bone loss at the alveolus.

less unilocular form, all showed some degree of faint septation. One of the most unusual (Fig. 7) appeared not unlike an area of direct carcinomatous invasion of bone or an epulis, while the other 3 bore some resemblance to certain of the follicular cysts.

DIFFERENTIAL DIAGNOSIS

In order to study the x-ray appearance of related multilocular lesions of the mandible, available material on fibrous dysplasia, giant-cell tumor, follicular cyst, hemangioma, and septate forms of cancer metastases was reviewed briefly.

For this purpose there were available 6 cases of fibrous dysplasia affecting the mandible. In addition to whatever clinical points of differentiation might be present in an individual case, it was found that in fibrous dysplasia there was no cortical destruction, but considerable expansion. The medullary border was indistinct, and the loculations were fewer and larger, showing no central nest pattern. The element of production, manifested by stippled calcification and sclerotic bands of septa, was more pronounced.

Five selected cases of follicular cyst were studied. All were of the less frequent polylocular variety, since it seemed that this rather than the common monolocular variety might more easily resemble the bulk of the adamantinomas. The age range closely paralleled that for adamantinoma. The multilocular form of follic-

ular cyst tends to expand the mandible symmetrically. Cortical destruction is minimal or, more often, entirely absent. The septa are fine and delicate and the loculations are large and present no central branching point. There is no scalloping of the medullary border. The locules are few in number. Most of the cysts occurred in the ramus.

Reliable material covering benign giant-cell tumor of the mandible was too scanty for critical study. It has been said by some that benign giant-cell tumor does not occur in the mandible (8). Material on osteitis fibrosa cystica with mandible changes is sufficient to indicate to us that there is no real similarity in the roentgen appearance of the giant-cell tumor lesions of that disease with adamantinoma.

In the few cases we have seen of the septate type of metastatic cancer involving the mandible there was always extensive bone involvement elsewhere. Moreover, it seemed that there was but the most superficial resemblance to adamantinoma. One case of a somewhat unusual sarcoma of the mandible was erroneously diagnosed by us as adamantinoma radiographically. This is reported elsewhere in some detail (19). A single case of angioma of bone seen in the mandible seems sufficiently unlike adamantinoma to present any confusion in roentgen diagnosis. At times the recurrent adamantinoma may defy recognition without adequate history.

SUMMARY

1. Thirty adamantinomas histologically confirmed have been studied in an attempt to establish roentgen criteria for diagnosis.

2. The material is divided into a typical group of 24 tumors and an atypical group of 6 tumors on the basis of roentgen appearance.

3. The study indicates that most adamantinomas present a characteristic roentgen picture permitting a dependable diagnosis by the roentgenologist.

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SUMARIO

El Aspecto Roentgenológico del Adamantinoma de la Mandíbula

Repásanse aquí 30 casos comprobados de adamantinoma mandibular con referencia particular a los hallazgos radiológicos. Juzgando por esto, parece que el conocimiento profundo del aspecto y comportamiento del tumor y el cuidadoso análisis de las características roentgenológicas conducirán a un diagnóstico acertado en la gran mayoría de los casos.

El adamantinoma típico está localizado en el cuerpo del maxilar inferior, en el angulo, ocupando una posición asimétrica en relación con el eje central del hueso. El desarrollo es hacia afuera a través de la corteza, por lo general en la cara alveolar, casi siempre con alguna destrucción cortical. La característica más típica es la naturaleza locular del tumor. Las loculaciones suelen ser múltiples y varían en tamaño, pareciendo irradiar de un nido central o núcleo. Por lo regular se observa una prolongación o tumefacción de tejido blando que contiene tabiques más o menos bien formados.

Los adamantinomas atípicos, 6 de los cuales figuran en la serie actual, plantean un problema diagnóstico más difícil. Uno del grupo no era muy distinto de una metástasis carcinomatosa o una epúlide. Otros semejaban quistes foliculares.

Cardioangiography[1]

H. A. CREGG, M.D., P. W. SMITH, M.D., C. W. WILSON, M.D., and J. W. BULL, M.D.

CARDIOANGIOGRAPHY (roentgenography following direct cardiac injection of a radiopaque medium) is a new and experimental method which, if successful, may advance our diagnostic abilities in heart disease. Angiocardiography (indirect cardiac injection by the venous route) is now a common practice for evaluation of some specific cardiovascular anomalies, but it is not altogether satisfactory.

In 1951, Sussman and Brahms (11) made a rather critical analysis of angiocardiography, calling attention to certain technical difficulties of the procedure and to anatomical and physiological factors which interfere with interpretation of the results. Of the shortcomings which they mention, the one with which we are chiefly concerned here is the poor delineation of the left ventricle and its outflow tract, as a result of which angiocardiographic diagnosis of subaortic stenosis is usually unsuccessful.

That angiocardiography is not without risk is indicated by the report, by Dotter and Jackson (3), of a collected series of 26 deaths in 6,824 angiocardiographic examinations. It was learned, by analysis of these cases, that the mortality was independent of the nature of the contrast medium, the number of the injections, premedication, or general anesthesia. The death rate was higher in children, in patients with congenital heart disease, and in patients receiving large doses of the medium. Though the mechanisms of death were difficult to substantiate in the absence of positive findings at autopsy, they appeared to be due not to allergic reaction but usually to sudden respiratory arrest following the injection of the medium.

It is apparent that, radiographically speaking, the most desirable method for visualizing the heart calls for the injection of as large a bolus of as dense a medium as possible in the shortest possible time. This accomplishment depends directly upon the size of the opening of the channel carrying the medium, the distance from the site of the injection to the cardiac chamber, and the force of the injection. Sutton *et al.* (12) pointed out the great advantage in by-passing the venous blood entering the heart by direct injection of the right auricle through a jugular vein catheter. The introduction of a radiopaque medium immediately into the right auricle improved visualization of both the right and the left sides of the heart.

The idea of injecting contrast media directly into the heart by one means or another must have occurred to many investigators. The introduction of catheters of various sorts into the right side of the heart and the retrograde threading of a catheter through the aortic valve and into the left ventricle have been used for this purpose. The trauma of cardiac puncture at first thought might seem unduly hazardous. Yet it is well known that for many years physicians have been injecting adrenalin and other substances directly into the heart as a means of cardiac resuscitation. The left atrium has been intentionally punctured through the bronchoscope for direct recording of the pressures in that chamber. Anyone who has done any appreciable number of pericardial taps will recall the frequency with which ventricular blood was obtained. Insertion of instruments of various shapes and sizes into the ventricular chambers at the operating table is now rather commonplace. Ponsdomenech and Beato Núñez (7), of Cuba, in 1951 reported on 45 ventricular punctures in 30 human subjects without mortality. They used a subxyphoid approach to the diaphragmatic surface of the heart and injected

[1] Accepted for publication in August 1954.

70 per cent Diodrast. This procedure they called cardioangiography.

To evaluate this method of examination further, we carried out 75 ventricular punctures in 18 dogs, injecting 70 per cent Diodrast into the right or left ventricle. Electrocardiograms were made before, during, and after the procedure. Fluoroscopic or radiographic visualization of the heart and great vessels was accomplished during the injection. Those animals that died were autopsied and those that survived were sacrificed and autopsied at intervals ranging from immediately to fifty-three days after the last ventricular puncture. Gross and microscopic observations of the heart and other organs were recorded.

These experimental studies have been reported in detail elsewhere (10) and it is necessary only to summarize the findings here. Table I shows the complications encountered among 13 dogs in which 60 subxyphoid punctures were done. Only one death occurred as the direct result of the procedure in this group in which the subxyphoid approach to the heart was employed. In this animal ventricular fibrillation developed following the intramyocardial injection of a portion of the contrast medium. This was the only instance, in the entire series of 75 ventricular punctures, of ventricular fibrillation. The danger of intramyocardial injection of the medium was enhanced by our use of a sharp long-beveled needle in the animal work. A short-beveled needle was then made for application of the procedure to man, which should minimize this danger.

TABLE I: COMPLICATIONS OF CARDIOANGIOGRAPHY OCCURRING WITH 60 SUBXYPHOID VENTRICULAR PUNCTURES IN 13 DOGS.

Type of Complication	Times Observed	Clinical Effect
1. Intramyocardial injection of portion of contrast medium	1	Ventricular fibrillation and death
2. Mild laceration of left lobe of liver	1	None
3. Intrapericardial injection of portion of contrast medium	2	None
4. Renal damage (contrast medium other than Diodrast employed)	2	Transient gross hematuria

The intercostal approach to the heart, which was utilized in the first 15 ventricular punctures, was abandoned after one laceration of a coronary vessel with resulting cardiac tamponade. Ponsdomenech and Beato Núñez pointed out the increased safety of approaching the diaphragmatic surface of the heart because of the decreased number and size of coronary vessels. Laceration of a coronary vessel has not occurred in the dog or man with this approach, in our experience.

Electrocardiographic changes in the dogs subjected to ventricular puncture included the constant appearance of ventricular extrasystoles when the needle tip came in contact with the ventricular wall. Ordinarily these disappeared when access had been gained to the ventricular chamber. Transient ventricular tachycardia was induced purposefully on one occasion by injection of an overdose of 70 per cent Diodrast into the left ventricle. Ventricular tachycardia also followed the intramyocardial injection of a portion of the contrast medium by the intercostal approach. In this instance, the dog was promptly sacrificed to determine the cause of the arrhythmia. Other changes in the electrocardiogram were of less significance and will be reported elsewhere.

The gross and microscopic pathological changes in the hearts of these dogs included the presence of a few cubic centimeters of bloody fluid in the pericardial cavity of those animals sacrificed within the first three days following ventricular puncture. After this time no blood or adhesions were found in the pericardial cavity. A minute area of focal hemorrhage followed by focal inflammatory reaction and ultimately by focal scarring, often detected only on microscopic examination, was noted in the epicardium and myocardium at the site of puncture.

To date we have carried out this procedure in only 8 human cases. There has

Fig. 1. Cardioangiogram in a case of coarctation of the aorta. The competent mitral valve appears as a negative defect.

been no mortality in this group, but in 1 patient ventricular fibrillation developed, lasting 180 seconds before sinus rhythm was restored by cardiac massage. This complication probably was caused by an overdose of Diodrast injected so slowly as to result in prolonged coronary transit and prolonged myocardial ischemia. No significant complications were encountered in the other 7 patients.

At present we employ a short-beveled 15-gauge needle attached to a 20-c.c. Luer-Lok syringe and inject manually as rapidly as possible 20 c.c. of 70 per cent Diodrast. The Cuban investigators injected 50 c.c. with a measured-pressure device, and animal experimentation is planned for further evaluation of this technic. The advantage of injecting a larger volume of the contrast medium, if it can be done rapidly, is apparent. Local anesthesia with proper sedation is entirely adequate if the patient can co-operate. At present all necessary personnel and equipment for carrying out resuscitation are kept at hand, should the need arise. Continuous electrocardiographic tracings are made during the procedure, and the patients are observed carefully for several hours after its completion. Once

Fig. 2. Cardioangiogram in a case of mitral regurgitation, showing left auricular opacification.

the technic is perfected, it should not be time-consuming, the anesthesia should be simple, and the patient should not have to be taken to the operating room. The equipment needed to obtain the films would presumably be far less than is necessary for either angiocardiography or retrograde aortography.

With this technic we expect to attain better visualization with smaller amounts of contrast medium, which is important in safely examining children with congenital heart disease. At the present time retrograde aortography is to be preferred in the

diagnosis of aortic lesions in the adult. Films obtained during cardioangiography show little decrease in concentration of the medium in the passage from the right to the left side of the heart. This is true because a great quantity of diluting venous blood is by-passed when the injection is made into the right ventricle. *Pulmonic stenosis*, for which angiocardiographic visualization has been considered untrustworthy (Cooley, 2), should be much more easily visualized. The decrease in dilution should be of great value, also, in the visualization of *interatrial septal defect*, although we do not know that we could demonstrate the size of the defect. According to available sources on angiocardiography in congenital heart disease, *interauricular defect with pulmonic stenosis* cannot be differentiated from *tetralogy of Fallot*. One function of cardioangiography should be to separate these two anomalies in a distinct manner.

Injection directly into a left ventricle with competent valves will fill it with contrast medium, there being a reduction of the usual proportion of diluting blood. This feature permits excellent visualization of the *aortic* and *mitral valves* and left-to right *interventricular shunts*. Figure 1 is a film taken in a man with a coarctation of the aorta. The competent mitral valve is seen as a negative defect. Figure 2 is the film of a patient with mitral regurgitation. Figure 3 shows the aorta and coronary vessels in a patient with a superior mediastinal mass. The valves of the aorta are quite clearly visualized. The left ventricular puncture was made to obtain aortic visualization in an effort to differentiate superior mediastinal neoplasm from an aneurysm of the aorta. The lesion proved to be the former.

Fig. 3. Cardioangiogram in a patient with a superior mediastinal neoplasm. Aneurysm of the aorta excluded.

SUMMARY

In 1951, Ponsdomenech and Beato Núñez reported 45 ventricular punctures in 30 patients, without mortality. They injected 50 c.c. of 70 per cent Diodrast and called the procedure cardioangiography.

We have carried out 75 ventricular punctures in 18 dogs and 8 ventricular punctures in 8 human beings.[2] The greater opacification, particularly of the left side of the heart, should lead to the more accurate diagnosis of certain congenital and acquired lesions of the heart and great vessels. Thus far we have not undertaken this work in children or in patients with cyanotic heart disease. Until the method has been more thoroughly evaluated we cannot express an opinion concerning its hazards.

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[2] Since this report was submitted for publication, 11 additional ventricular punctures have been done without mortality or morbidity.

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SUMARIO

Cardioangiografía

La angiocardiografía (radiografía consecutiva a la inyección directa de un medio de contraste en el corazón) fué descrita por Ponsdomenech y Beato Núñez en 1951. Ejecutaron estos autores 45 punciones ventriculares, con inyección de Diodrasto al 70 por ciento, sin mortalidad.

Los actuales AA. han repetido este procedimiento en el hombre y los animales, haciendo 75 punciones ventriculares en 18 perros y 8 en 8 seres humanos. La vía subxifoidea resultó superior a la intercostal. En 13 perros en que se empleó la primera, no hubo más que una muerte atribuíble al procedimiento, siendo éste el único caso de toda la serie de animales en que hubiera fibrilación ventricular. No hubo mortalidad entre los 8 sujetos humanos, ni tampoco complicaciones, excepto por la aparición de fibrilación ventricular en un solo caso, debida probablemente a una hiperdosis de Diodrasto, inyectada con tanta lentitud que dió por resultado prolongación del paso por las coronarias e isquemia miocardiaca. En este caso, se restableció el ritmo sinusal al cabo de 180 segundos, con el masaje cardíaco.

Parece que la mayor opacificación obtenida, en particular del lado izquierdo del corazón, debe conducir al diagnóstico más exacto de ciertas lesiones del corazón y de los grandes vasos.

Ornithosis as an Occupational Hazard[1]

BERNARD ROSEN, M.D.[2]

ORNITHOSIS is a virus infection transmitted primarily from infected poultry to man. It is differentiated in name from psittacosis in that it is transmitted from non-psittacine birds (psittacine referring to the beak characteristic).

The fact that ornithosis can be a rapidly developing and incapacitating disease was established in Corsicana, Texas, at a poultry processing plant in April 1954. Forty-eight employees, out of a total of 120, all of whom either worked in the picking or eviscerating section of the plant became severely ill between April 8 and 12. Thirty-four patients admitted to the Navarro County Memorial Hospital form the basis for this report. In 15 of the number, radiographic examinations of the chest were made.

ETIOLOGY

The causative organism of ornithosis is classified as a virus, its generic name being *Miyagawanella psittaci*. In size, however, it lies between a true virus and *Rickettsia*. It can be stained by Castaneda's and Macchiavello's methods for *Rickettsia* The elementary bodies measure from 0.3 to 0.5 micra and can easily be seen with the oil immersion lens of an ordinary microscope. A definite life cycle is noted as large plaques are formed in the infected cells and then break down into the smaller elementary bodies.

The virus can be made to propagate in the yolk sac of the chick embryo. Following injection of the virus into the peritoneal cavity of the mouse, inclusion bodies are demonstrable in the mononuclear cells of the liver and spleen.

EPIDEMIOLOGY

Ornithosis has been transmitted by both psittacine and non-psittacine birds (1, 13, 15, 16). Irons (9) described an outbreak in another poultry processing plant in Texas in 1950, in which turkeys were found to be the transmitters of the disease. Meyer and Eddie (12) described a new strain of virus from that outbreak.

The carriers in the epidemic to be described here were also turkeys and the disease was transmitted to man by fomites, as the excreta, the viscera, or nasal discharges. No employee of the plant outside of the picking or eviscerating section was infected.

Turkey poults from the infected lot were found to have ornithosis by the Poultry Section of Texas A. and M. College on March 21, 1954. The flock was later sold to the poultry processing plant and the birds were processed on April 1, 1954. The first case was reported on April 8, which coincides with the usual incubation period of seven to fourteen days.

Numerous cases of authenticated human-to-human spread have been reported. The virus has been demonstrated in the sputum of individuals without clinical evidence of the disease. Meyer and Eddie (11) reported a carrier with the virus demonstrable in the sputum eight years after a known infection.

PATHOLOGY

Fortunately there were no deaths in this series, but Boyd (4) has described the lesions as seen in psittacosis. The lung is mainly involved. There is a patchy pneumonia, with very little fibrin in the exudate and no fibrinous pleurisy. The characteristic lesion is a remarkable swelling of the epithelium lining the alveoli and proliferation of the cells as indicated by numerous mitotic figures. As a result of desquamation, the proliferated cells may plug the alveolar ducts, causing segmental areas of

[1] Accepted for publication in September 1954.
[2] Director of Radiology, Navarro County Memorial Hospital, Corsicana, Texas.

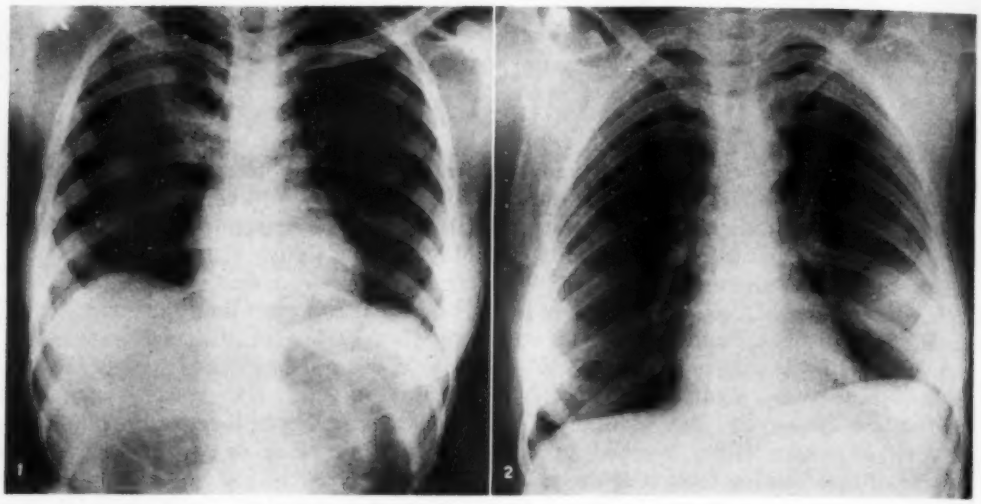

Fig. 1. Linear infiltrations extending from the right hilar region, with a more circumscribed area of infiltration in the right upper lobe, right middle lobe, and base.
Fig. 2. Type of change in the left lower lung field which should make the examiner mention ornithosis in the differential diagnosis, namely, a circumscribed area of infiltration with poorly defined margins.

atelectasis. Secondary infection may result in necrosis and abscess formation.

Passive congestion of the liver and spleen occurs. Hyaline degeneration of the spleen may be noted adjacent to the arterioles.

SYMPTOMATOLOGY

Most of the patients admitted to the hospital presented similar symptoms, including severe headache, muscle pain confined mostly to the neck, shoulder, and lumbar region, gastrointestinal tenesmus without diarrhea, profuse sweating with chills, and pharyngitis. A minority of the patients showed impairment of the sensorium, attributed to a predilection of the toxin for the brain tissues. Photophobia was observed infrequently. As is true in many of the so-called atypical pneumonias, there were few symptoms referable to the respiratory system initially, in spite of the radiographic findings. Forty-eight to seventy-two hours after the onset, severe cough and expectoration were noted.

PHYSICAL AND LABORATORY FINDINGS

The temperature on admission ranged from 99.6 to 105.4° F. Profuse sweating and chills were noted, frequently with dehydration, attributed to the sweating. Many of the patients appeared restless and apprehensive. The pulse rate did not exceed 90 per minute. Hyperemia of the pharynx was noted in many cases. Râles and decreased breath sounds over the involved lung segments were more pronounced two to three days following the onset of the illness.

No significant changes were noted on the neurological examination.

Two cases of right-sided heart failure were found in patients who had a previous history of cardiovascular disease. The pneumotropic effect of the virus contributed to the resistance of the pulmonary circulation.

Splenomegaly was not observed as a typical physical finding, though MacLachlan (10) found it to be a significant diagnostic point in ornithosis or psittacosis, when it occurs with atypical pneumonia.

The white blood count ranged from 5,200 to 11,700, with a normal differential picture. Agglutination tests for typhoid, paratyphoid, and *Proteus* OX19 were negative. Urine examinations were not of significance.

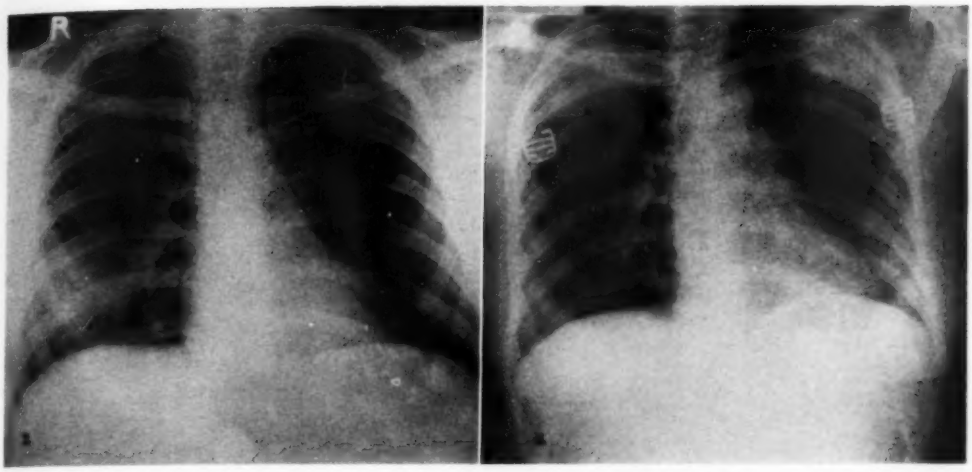

Fig. 3. Roentgenogram of the government inspector, showing a circumscribed area of infiltration with poorly defined margins.

Fig. 4. Bilateral areas of circumscribed infiltration with poorly defined borders. The bronchovascular markings in the involved areas show an increase in density, with irregular margins, indicating hyperemia of the lung parenchyma.

The single laboratory examination which proved of value in establishing the diagnosis was a complement-fixation test utilizing Lymphogranuloma venereum antigen. Sigel (13) found that antibody titers are suppressed by the broad-spectrum antibiotics, so that the complement-fixations may be low. Antibodies appear at the end of the first (14) or beginning of the second week. The titer quickly rises after the second week depending on the amount of antibiotic the patient receives in the interim. A rapid fall usually occurs in the third or fourth week. In an occasional patient the titer remains at a high level for several months.

Serologic diagnosis depends on demonstrating a rise in titer from a sample drawn early in the disease (first week) in another sample in the second or third week. A three- to fourfold rise in titer between different serum samples is diagnostic.

RADIOGRAPHIC FINDINGS

Although it has been previously stated (10, 13, 16) that there is nothing typical about the radiographic examination, a definite characteristic appearance was found in a majority of the patients in this series. Focal circumscribed areas of pneumonic consolidation occurred, involving one or more areas and not confined to any particular lobe or segment of the lung (Table I). In the so-called atypical pneumonias, as a rule, focal areas of consolidation are not as frequent as interstitial areas of infiltration.

In the radiographic diagnosis it is important to mention ornithosis when circumscribed areas of consolidation or infiltration are noted in cases of atypical pneumonia.

TABLE I: RADIOGRAPHIC FINDINGS

Focal circumscribed areas of pneumonia	10 cases
Single area	5 cases
Multiple area	5 cases
Interstitial infiltration as primary finding	5 cases

TREATMENT

Treatment consisted of antibiotics plus supportive measures. Tetracycline appears to produce the most rapid fall of temperature as well as clinical improvement. Green (8) has reported the use of aureomycin in psittacosis in man. Recently French *et al.* (7) reported on the use of the "broad-spectrum" antibiotics in ornithosis occurring in Australia.

The average hospital stay was seven days. There were 11 relapses after discontin-

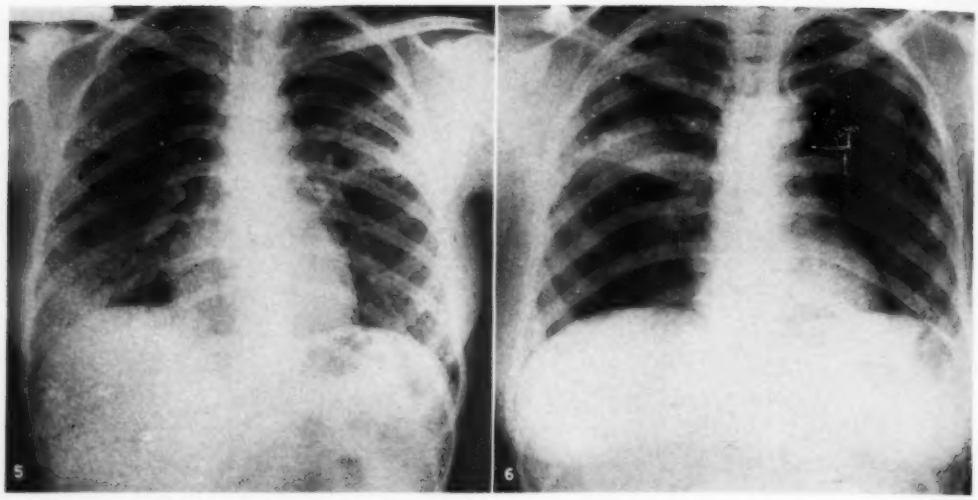

Fig. 5. Multiple areas of circumscribed infiltration in the left upper lobe and the right lower field. There is an increase in the interstitial markings in the right lower lung field, as well as the left lower lung field.
Fig. 6. Well defined area of consolidation limited by the minor fissure on the right. The fissure is elevated, indicating an element of atelectasis in the right upper lobe.

Fig. 7. The most widespread involvement of the lung observed in the series reported, the entire right upper lobe and left lower lobe being included in the disease process. In addition there is early lobular infiltration in the remainder of the right lung field.

uance of antibiotics which suggests that their use should be continued at least two weeks following return of the temperature to normal. Wolins (16) has indicated that the severity of the illness is milder in the young, who are less susceptible, and most serious in the older age group.

DIFFERENTIAL DIAGNOSIS

When the patient is first observed typhoid fever may be ruled out by a negative Widal reaction and stool culture. Absence of cold agglutinins and agglutinins for *Streptococcus MG* eliminate primary atypical pneumonia. To exclude influenza absolutely, negative agglutination tests (Hirst) and failure to isolate the influenza virus would be necessary.

SUMMARY

Forty-eight cases of ornithosis occurring in employees of a poultry processing plant are reported. Turkeys were found to be the carriers of the disease.

Radiographic examination of the chest in 15 cases showed circumscribed focal areas of pneumonia to be the predominant feature.

Ornithosis should be considered as an etiologic possibility when atypical pneumonias are diagnosed radiographically.

ACKNOWLEDGMENTS: I wish to thank the following physicians for the use of their cases: J. H. Barnebee, M.D., W. K. Logsdon, M.D., C. L. Gary, M.D., Will Miller, M.D., J. W. David, M.D., and R. D. Bone, M.D. Mrs. Margaret Bush, R.N., City-County Public Health Nurse, furnished the re-

ports on the complement-fixation titers. I. V. Irons, Sc.D., of the Texas State Department of Health, kindly furnished valuable laboratory data on the complement-fixation titers and isolation of the virus.

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SUMARIO

La Ornitosis como Riesgo del Trabajo

Preséntanse 48 casos de ornitosis observados en empleados de un establecimiento dedicado a la preparación de aves de corral para consumo. Los pavos resultaron ser los portadores de la dolencia.

El examen radiográfico del tórax en 15 casos reveló zonas focales circunscritas de neumonía como característica predominante.

Debe considerarse la posibilidad de ornitosis cuando se diagnostican radiográficamente neumonías atípicas.

The Radiotherapeutic Test: An Unreliable Diagnostic Procedure in Intrathoracic Mass Lesions[1]

EUGENE R. KUTZ, M.D.

THE RADIOTHERAPEUTIC test may be defined as a diagnostic procedure in which the histologic family to which a lesion belongs is determined by its response to a measured quantity of roentgen rays.

Desjardins (4) was one of the more enthusiastic proponents of the radiotherapeutic test. It was his belief that it is based on the well established fact that each variety of cell in the body has a specific sensitiveness, or a specific range of sensitiveness, to roentgen rays and radium. Because of this, he felt that the radiologist could distinguish absolutely between lymphoma and any variety of epithelial or connective-tissue tumor.

Desjardins published his opinion in 1933, which was the year in which the first pneumonectomy was performed for carcinoma of the lung. At that time thoracotomy was not used as a diagnostic procedure, because of the high morbidity and mortality rate. It was therefore necessary to resort to every possible method of diagnosis before thoracotomy was considered. Because of this, the radiotherapeutic test was frequently of value. Since 1933, advances in thoracic surgery have come rapidly. Thoracotomy is no longer considered dangerous, and it is frequently used to establish the diagnosis when simpler methods fail. This progress has dampened the enthusiasm for the radiotherapeutic method. The test is still being used, however, and as recently as 1946 it was recommended that it should precede surgery in every diagnostically doubtful case (3). At the present time there is seldom any reason to recommend a radiotherapeutic test preoperatively. If the diagnosis cannot be established by any of the conventional methods of diagnosis—bronchoscopic examination and biopsy, microscopic examination of bronchial washings, needle biopsy, or biopsy of an existing metastatic focus—thoracotomy is the next step unless contraindicated.

There are two reasons for avoiding the radiotherapeutic test:

1. When it is employed to make a diagnosis, operation may be delayed long enough to cause an operable lesion to become inoperable.

2. Because of the apparent variability in the response of lesions of similar histology to similar doses of x-rays, the test is frequently inaccurate.

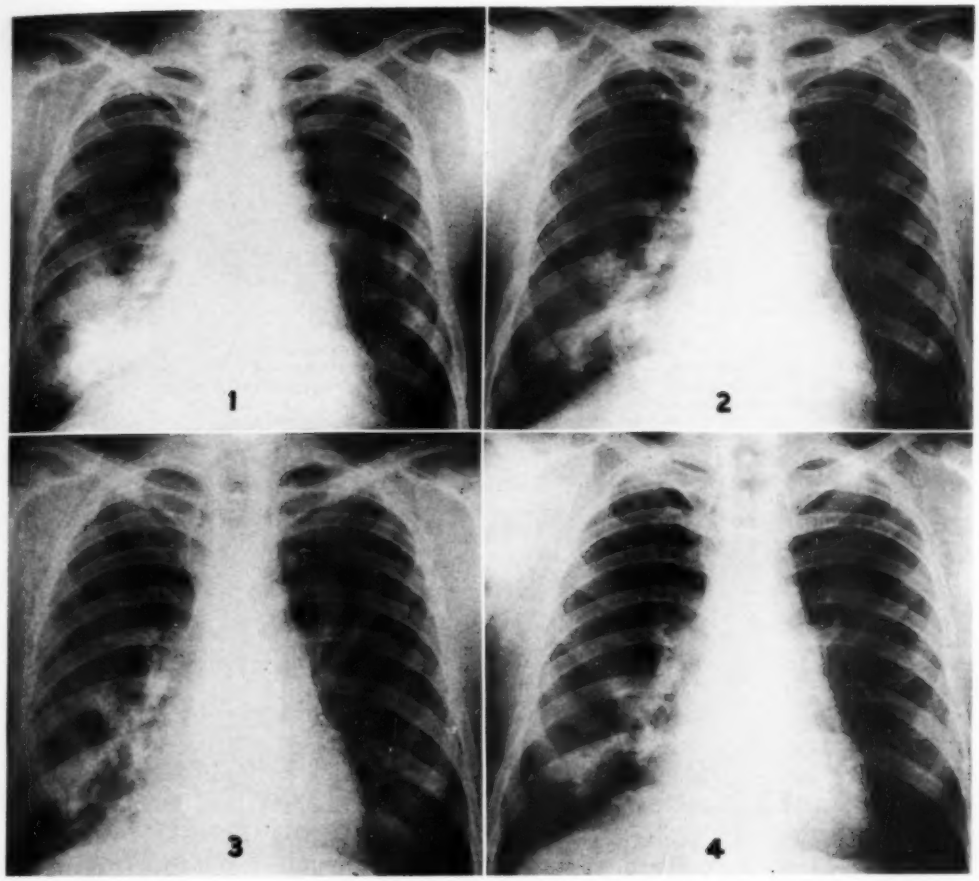
The inaccuracy of this method has been pointed out by other writers in the past, but it became more apparent to the members of our department when we reviewed all of the intrathoracic lesions which we had treated in a two-year period. Of 60 cases of malignant intrathoracic mass lesions treated, 23 were suitable for evaluation. They were histologically diagnosed, were easily visualized on roentgenograms, and had received enough radiation to produce a change in the size of the lesion. From these 23 cases, the following have been selected to demonstrate the variable response of histologically similar and dissimilar lesions to comparable radiation doses. All of the patients were treated by a 400-kv constant-potential generator. The half-value layer of the beam was 6.5 mm. Cu.

CASE REPORTS

CASE I: A 29-year-old white male physician was admitted to the hospital because of chest pain of four days duration. The pain involved the left side of the neck, the shoulder, and an area below the left scapula. There were no palpable masses. The only significant finding was on the chest roentgenogram which is reproduced in Figure 1. Diagnosis of this lesion was not made prior to the initiation of roentgen therapy. Figures 2–4 show the response of this lesion to the dosage indicated in the legend.

Approximately four months after irradiation, a

[1] From the Allegheny General Hospital, Pittsburgh, Penna. Accepted for publication in September 1954.



Figs. 1–4. Case I: Hodgkin's lymphoma.

Fig. 1. Initial chest roentgenogram demonstrating the lesion before treatment. There is involvement of the right lung, mediastinum, and pericardium.

Fig. 2. Marked regression of the intrathoracic lesion after a tumor dose of 1,125 r delivered in twelve days.

Fig. 3. Further regression of the intrathoracic lesion after a tumor dose of 2,878 r in forty days.

Fig. 4. Chest roentgenogram at the completion of therapy; 4,022 r was delivered to the estimated depth of the lesion in a period of fifty-two days.

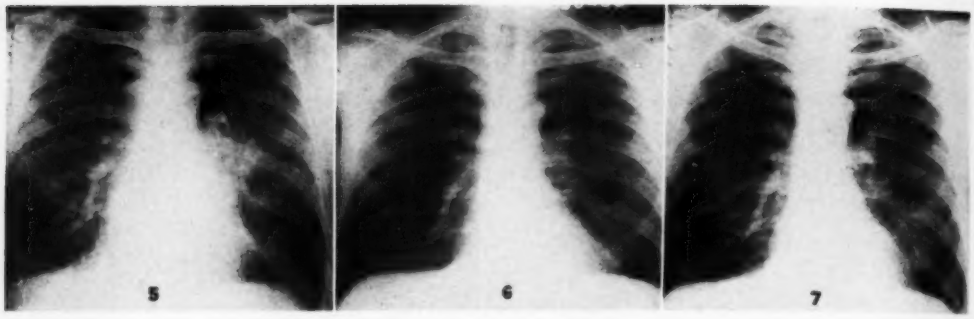
marrow biopsy from the iliac crest was diagnosed as Hodgkin's lymphoma. The patient is still living and apparently well two years following treatment.

Comment: The average daily tumor dose in this case was 80 r. From the response of the lesion, it was assumed to be a lymphoma. This conclusion was verified by the histologic findings four months later.

CASE II: A 52-year-old white male was admitted to the hospital because of dyspnea, cough, and chest pain. The physical examination revealed several hard fixed nodes in the supraclavicular area. The chest roentgenogram at the time of admission is shown in Figure 5. Roentgen therapy was initiated and Figures 6 and 7 demonstrate the response of this lesion to treatment. The histologic diagnosis, made by biopsy of the supraclavicular nodes, was undifferentiated carcinoma.

Comment: The average daily tumor dose to this lesion was 70 r, which is 10 r per day less than in Case I. Despite this lower dose rate, the response of lesion occurred at a rate equal to that of the preceding lymphoma.

CASE III: A 45-year-old white male was admitted to the hospital complaining of progressive swelling of the neck and face. He had severe head-

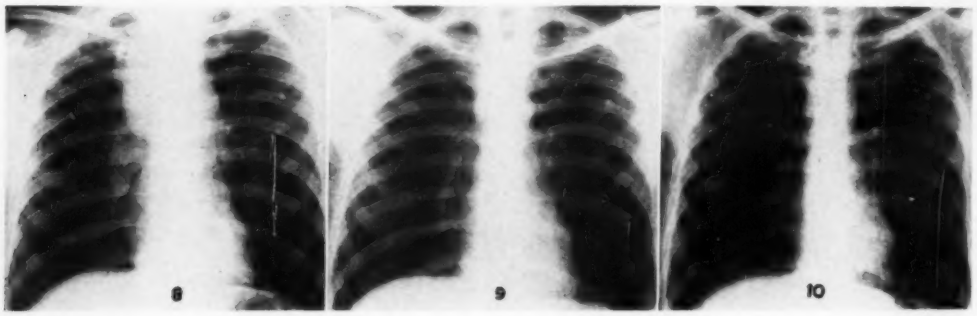


Figs. 5–7. Case II: Undifferentiated carcinoma.

Fig. 5. Initial chest roentgenogram demonstrating the lesion before treatment. There is involvement of the central portion of the left lung and the superior mediastinum. Note the large rounded mass protruding from the right side of the mediastinum at the level of the aortic arch.

Fig. 6. Almost complete regression of the tumor on the thirty-fifth treatment day. A total tumor dose of 2,328 r had been delivered to the lesion.

Fig. 7. Normal chest roentgenogram after 3,471 r had been delivered to the tumor in a period of fifty days.



Figs. 8–10. Case III: Undifferentiated carcinoma.

Fig. 8. Initial chest roentgenogram demonstrating large superior mediastinal lesion and involvement of the right hilus and lung.

Fig. 9. Appearance of the chest roentgenogram after a tumor dose of 1,779 r had been delivered in a period of twenty-three days. All that remains visible on the roentgenogram is slight superior mediastinal widening.

Fig. 10. Appearance of the chest at the completion of therapy; 2,622 r had been delivered to the tumor in a period of thirty-five days. The roentgenogram appears normal.

aches and substernal pain. There were palpable supraclavicular nodes, and a biopsy was taken. Irradiation was begun following a histologic report of undifferentiated carcinoma. Figures 8–10 show the lesion in the chest before therapy and its regression with irradiation.

Comment: Unlike the previous lesion, which responded like lymphoma but did not have the characteristic appearance of that tumor, this lesion resembled lymphoma both in appearance and response. The average daily tumor dose was 75 r per day. This is 5 r per day lower than the dose in Case I. Despite this, the rate of response was extremely rapid and, roentgenographically at least, complete. Figure 9 demonstrates almost complete regression of the mass with a total tumor dose of 1,779 r in twenty-three days. If this had been a radiotherapeutic test, I feel certain we would have made a diagnosis of lymphoma.

CASE IV: A 48-year-old white male was admitted to the hospital with a history almost identical to that in Case III. He had marked superior vena caval obstruction. The initial chest roentgenogram is shown in Figure 11. X-ray therapy was initiated and by the seventeenth treatment day the total tumor dose had reached 1,077, r. Figure 12 shows the appearance of the chest ten days following interruption of therapy because of radiation sickness. Although this roentgenogram demonstrates a definite response, the clinical improvement was

Figs. 11 and 12. Case IV: Undifferentiated carcinoma.
Fig. 11. Initial chest roentgenogram, demonstrating marked widening of the superior mediastinal shadow.
Fig. 12. Chest film ten days following radiation therapy. A total tumor dose of 1,077 r was delivered to the lesion in seventeen days. There is considerable regression in size as compared with the original film.

more remarkable. The superior vena caval obstruction was completely relieved. When the neck swelling disappeared, several nodes were palpable in the right supraclavicular area. The histologic diagnosis was undifferentiated carcinoma.

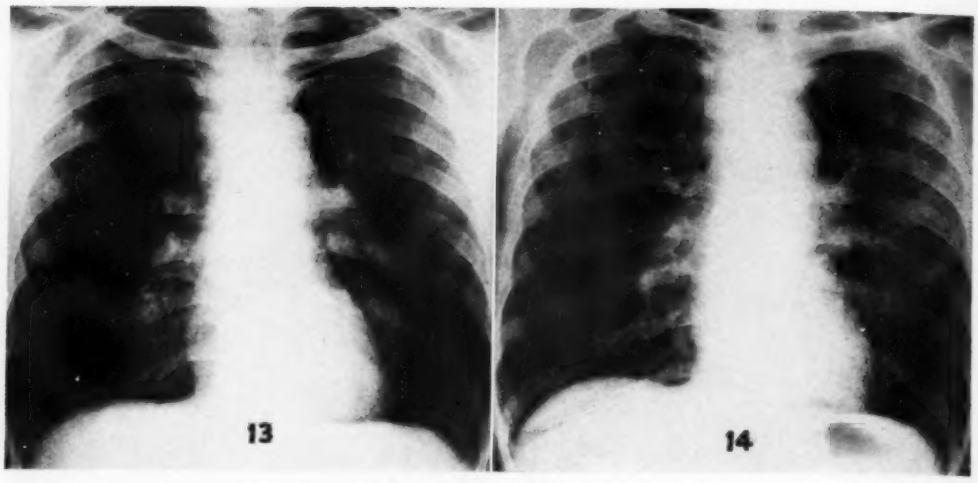
Comment: This patient was referred to us for a radiotherapeutic test. Because of his condition, we felt justified in treating him without a diagnosis. From his response to treatment and the appearance of the mediastinal lesion, we felt we were dealing with lymphoma. The histologic diagnosis was undifferentiated carcinoma. Despite the response to irradiation, death ensued a few weeks after treatment.

CASE V: A 58-year-old white male was referred for radiation therapy because of a mediastinal mass, moderate superior vena caval obstruction, and enlarged supraclavicular nodes. His only subjective symptom was chronic cough. The admission roentgenogram is shown in Figure 13. The diagnosis of undifferentiated carcinoma was made by biopsy of a supraclavicular node, and radiation therapy was initiated immediately. Figure 14 shows the response of the lesion to treatment.

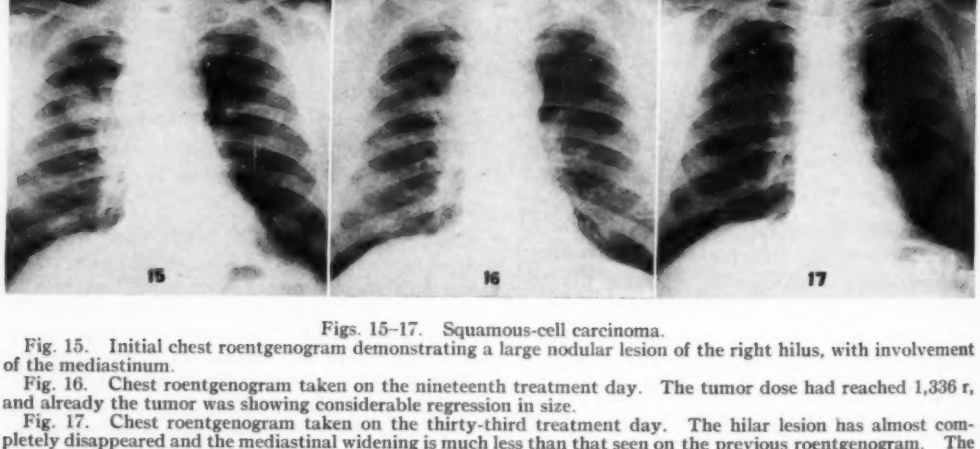
Comment: This case demonstrates the variability in the response of histologically similar lesions. This chest lesion closely resembled the preceding two, yet it was almost unchanged following a tumor dose of 3,015 r in a period of thirty-five days. The average daily dose was 86 r, which was higher than in either of the other two cases.

CASE VI: A 58-year-old white male was admitted to the hospital with a history of cough, chest pain, and slight hemoptysis of about one month duration. The admission chest roentgenogram is shown in Figure 15. The thoracic surgeon would not consider thoracotomy, and the patient was referred to the radiotherapy department. X-ray irradiation was initiated and Figures 16 and 17 demonstrate the response. Treatment was continued until the thirty-seventh day, for a total tumor dose of 3,300 r.

Comment: This case illustrates an unusually sensitive squamous carcinoma. The diagnosis was not known for almost one year after therapy. Because of the response to treatment, lymphoma was considered a possibility, but the clinical course did not verify this diagnosis. Until the time of autopsy, undifferentiated carcinoma was thought to be the most likely diagnosis. The average daily tumor dose was 88 r per day.



Figs. 13 and 14. Case V: Undifferentiated carcinoma.
Fig. 13. Initial chest roentgenogram demonstrating widening of the superior mediastinum.
Fig. 14. Chest roentgenogram following a dose of 3,015 r to the tumor in a period of thirty-five days. Note the lack of response, despite the tumor dose.



Figs. 15–17. Squamous-cell carcinoma.
Fig. 15. Initial chest roentgenogram demonstrating a large nodular lesion of the right hilus, with involvement of the mediastinum.
Fig. 16. Chest roentgenogram taken on the nineteenth treatment day. The tumor dose had reached 1,336 r, and already the tumor was showing considerable regression in size.
Fig. 17. Chest roentgenogram taken on the thirty-third treatment day. The hilar lesion has almost completely disappeared and the mediastinal widening is much less than that seen on the previous roentgenogram. The tumor dose had reached 2,811 r

CONCLUSION

This paper is not meant to be a condemnation of the practice of treating intrathoracic mass lesions of undetermined histology. There will always be patients on whom a diagnosis cannot be made by conventional methods who will not submit to diagnostic thoracotomy, patients whose general condition contraindicates thoracotomy, and patients with obviously advanced disease for which palliation is all that is possible. These patients should have irradition but with treatment as the primary objective, not diagnosis. It is important to avoid the term radiotherapeutic test, because it implies that diagnosis is the primary object and therapy a secondary goal. The purpose of all radiation therapy should be either cure or palliation. If cure is the goal, the patient should be given the optimum dose for the most radioresistant histologic type that the

existing lesion could be. Radiosensitivity, if present, should not deter the therapist from reaching a predetermined dose. Above all, irradiation should never be started with the idea that the response will determine whether or not operation should be undertaken. If the lesion is an operable one, it should be operated upon prior to radiotherapy. If it is inoperable, irradiation should be initiated with cure or palliation as the objective.

The radiotherapeutic test is based on the interpretation of the radiosensitivity of a tumor by a competent radiologist. If the test were a reliable one, an experienced radiologist or radiation therapist should find it possible, from a series of films taken during the course of roentgen therapy, together with information as to the tumor dose and history, to give an approximate diagnosis of the tumor type. Three radiologists reviewed the 23 cases mentioned above and all had difficulty in determining the approximate histology from the clinical and roentgenographic evidence. It would seem unwise to place any reliance upon such an inaccurate diagnostic procedure.

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SUMARIO

La Prueba Radioterapéutica: Procedimiento Diagnóstico Incierto en las Lesiones Tumorosas Intratorácicas

La prueba radioterapéutica ha sido definida como procedimiento de diagnóstico en el que se determina la naturaleza histológica de una lesión por su respuesta a una dosis conocida de irradiación.

En una serie de 23 lesiones tumorosas intratorácicas malignas, esta prueba se mostró insegura. Se describen e ilustran 6 casos para demostrar la semejanza de la respuesta de distintas formas histológicas y la diferencia en la respuesta de lesiones histológicamente similares.

Aunque hay sin duda indicaciones para la irradiación de las lesiones tumorosas, debe emprenderse siempre la misma como providencia terapéutica, ya para la curación o la paliación, y nunca puramente para diagnóstico o con la idea de determinar si debe o no hacerse una operación. Si la lesión es operable, debe ser operada antes de la irradiación. Si es inoperable, debe emprenderse la irradiación, teniendo siempre como objetivo la curación o la paliación.

Studies with Radioiodine

V. Validity of Histologic Determination of I^{131} Radiation Changes in the Thyroid Gland[1]

EARL R. MILLER, M.D., STUART LINDSAY, M.D., and MORRIS E. DAILEY, M.D.

WHEN TISSUES have been irradiated with I^{131} and are subsequently examined, any histologic changes almost inevitably will be considered to be, at least in part, the result of that irradiation. On the other hand, small amounts of radiation may cause no recognizable histologic effects. In the thyroid gland the effects of disease, of aging, and of drugs may be present in the tissues and may be attributed to the radiations from I^{131} rather than to the true causes. Such errors of interpretation may easily lead to an inaccurate description of the lesions induced by irradiation.

This paper, consisting of four parts, presents the results of an investigation intended to detect changes in thyroid tissue due to radiations from I^{131} and to distinguish them from changes attributable to other causes. The first part is an account of four test-retest studies in which one of us (SL), a pathologist, attempted to distinguish irradiated from non-irradiated tissues by their histologic appearance; the second part is an analysis of the consistency and reliability of these interpretations, undertaken for the purpose of finding those sections of tissue which would show unmistakably the effects of irradiation. These tissues were then studied histologically and are carefully described in the third part. The fourth part considers the differentiation of those histologic characteristics which were attributed to irradiation from those due to other causes.

I. TEST-RETEST STUDIES

Materials and Methods: The materials studied consisted of microscopic slides of thyroid tissue from 19 unirradiated patients and from 20 patients who had received radiation from I^{131}.[2] The sections of unirradiated tissues showed evidences of various thyroid diseases. Some of the glands had been subjected to the action of propylthiouracil and stable iodine in the form of Lugol's solution. Among the 20 sections of tissues that had been irradiated with I^{131},[3] 19 came from patients having toxic diffuse goiter and one came from a normal portion of the gland of a patient who had a thyroid carcinoma. Fifteen of the irradiated tissues had also been subjected to the action of propylthiouracil and/or stable iodine. After examination of the histologic section, the pathologist stated whether or not, in his opinion, the tissue showed evidence of having been irradiated.

In studies of this kind, definitions of terms and description of procedures are of great importance. All the tissues showed various degrees of the effect of naturally occurring diseases of the thyroid[4], treatment with drugs and agents other than irradiation, or of aging. For the purposes of the test-retest studies, the following meanings were adopted for *negative*, or non-irradiated (−), and *positive*, or irradiated (+).

Definition of Negative: Those tissues showing only the above changes were marked negative, or non-irradiated.

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[1] From the Departments of Radiology, Pathology, and Medicine of the University of California School of Medicine, San Francisco, Calif. Accepted for publication in September 1954.

This work was supported by the U. S. Atomic Energy Commission, the cancer research funds of the University of California, and the Cancer Research Institute of the University of California School of Medicine, San Francisico.

[2] Details of the radioiodine studies have been reported by Miller *et al.* (8–10).

[3] The radioactive iodine (I^{131}) used contained approximately 10^{-11} gm. per μc of activity. There was, therefore, no iodine effect *per se* from I^{131}. All effects of this radioiodine were radiation effects.

[4] "Naturally occurring diseases of the thyroid" is used here to designate various processes in the thyroid gland such as hyperplasia, nodular goiter, Hashimoto thyroiditis, etc., as distinguished from processes resulting from irradiation.

TABLE I: RESULTS OF TEST-RETEST STUDIES

Case No.	Age and Sex	Diagnosis	Previous Treatment*	Time between Last Dose and Operation (days)	Time between First and Last Dose (days)	Total Dose I^{131} (mc)	Pathologist's Opinion 1	2	3	4
				Non-Irradiated Cases						
1	65F	Graves	I	...	...	0	+	..	−	−
2	25M	Graves	I	...	...	0	−	..	−	−
3	51M	Graves	I	...	...	0	−	..	−	−
4	75F	Graves	I	...	...	0	−	..	−	−
5	22F	Graves	P	...	...	0	−	..	−	−
6	22F	Graves	I	...	...	0	−	..	+	−
7	32F	Nodule†	O	...	...	0	−	..	−	−
8	27F	Nodule†	O	...	...	0	−	..	−	−
9	28F	Nodule†	O	...	...	0	−	..	−	−
10	51F	Nodule†	O	...	...	0	−	..	−	−
11	59F	Nodule†	O	...	...	0	−	..	−	−
12	68F	Carcinoma†	O	...	...	0	−	..	−	−
13	70F	Carcinoma†	O	...	...	0	+	..	−	−
14	42F	Invol. nodule	O	...	...	0	−	..	−	−
15	37F	Hashimoto‡	O	...	...	0	−	..	−	−
16	46F	Hashimoto‡	O	...	...	0	−	..	−	−
17	62F	Hashimoto‡	O	...	...	0	−	..	−	−
18	36F	Granulomatous‡	O	...	...	0	−	..	−	−
19	38F	Granulomatous‡	O	...	...	0	−	..	−	−
					Number positive		2	..	1	0
					Number negative		17	..	18	19
					Number of observations		19	..	19	19
				Irradiated Cases						
20	40F	Graves	PI	1	14	0.88	−	−	−	−
21	32F	Graves	I	1	29	0.94	+	+	−	+
22	35F	Graves	PI	1	46	1.04	−	−	−	−
23	5F	Graves	PI	17	5	1.05	−	−	−	−
24	24F	Graves	I	67	1	1.88	−	−	−	−
25	70F	Graves	O	17	32	1.96	×	−	−	−
26	55F	Graves	PIX	1	50	2.07	+	−	−	−
27	42M	Graves	X	14	1	3.75	+	−	−	−
28	40M	Graves	PI	35	16	4.92	+	−	−	−
29	22F	Graves	O	1	64	4.54	−	−	−	−
30	51F	Graves	PI	19	44	5.07	−	+	−	−
31	63M	Graves	O	2	93	5.46	−	−	−	−
32	26M	Graves	PI	12	1	7.00	×	+	+	−
33	61F	Graves	PI	48	1	7.50	+	+	+	−
34	32F	Graves	O	11	43	8.20	−	−	−	−
35	31F	Graves	PI	86	62	10.55	−	−	−	−
36	64F	Graves	O	35	547	15.68	+	+	+	+
37	28F	Graves	O	298	235	21.82	+	+	+	+
38	47F	Graves	PI	96	125	23.45	+	+	−	+
39	53M	Carcinoma	O	1	79	52.18§	+	+	+	+
					Number positive		9	8	5	5
					Number negative		9	12	15	15
					Number of observations		18	20	20	20
					Total number of observations		37	20	39	39

* Previous treatment: P. Propylthiouracil. I. Lugol's solution. X. X-ray. O. No treatment.
† Normal tissue from gland having indicated disease.
‡ Hashimoto thyroiditis.
§ 47.4 mc of I^{131} was given twenty-four days before surgery.
Note: The two cases marked "×" in Study 1 were not available for the test.

Definition of Positive: (*a*) Those tissues which showed the above changes *plus* changes compatible with the effect of irradiation were marked positive, or irradiated. (*b*) Those tissues which showed changes which were dissimilar from the above changes *and* were compatible with the effect of irradiation were marked positive or irradiated.

In the first of the test-retest studies, all the slides were mixed and were presented to the pathologist without any clinical information (see Table I, Pathologist's Opinion, 1).

In the second study, only those tissues

TABLE II. INTRA-INDIVIDUAL VARIATION OF PATHOLOGIST'S OPINIONS

Definition 1: A positive reading on a case in Study 2 defines the case as *positive.* A negative reading on a case in Study 2 defines it as *negative.*

Study (No.)	Number of Readings	Number of Positive Readings	Number of Negative Readings	False Positives	False Negatives
On the 8 cases called positive in Study 2					
1, 3, 4	23	16	7	...	30.4%
3, 4	16	10	6	...	37.5%
On the 12 cases called negative in Study 2, and on the 19 non-irradiated cases					
1, 3, 4	92	6	86	6.5%	...
3, 4	78	1	77	1.3%	..

Definition 2: A majority of positive readings on a case defines it as *positive.* A majority of negative readings on a case defines it as *negative.*

Study (No.)	Number of "Negative" Cases	Number of "Positive" Cases	Total Number of Readings	Number of Positive Readings	Number of Negative Readings	False Positives	False Negatives
1, 2, 3, 4	32	..	108	7	101	6.5%	...
2, 3, 4	32*	..	76	2	74	2.6%	...
1, 2, 3, 4	..	7	27	23	4	...	14.8%
2, 3, 4	..	7	21	17	4	..	23.5%

* Includes all non-irradiated cases.

that had been irradiated were presented to the pathologist for his opinion. In this study he was informed that all of these tissues had been irradiated with I^{131}, but he was not informed regarding the dose, duration of treatment, interval between treatment and removal of tissue from the gland, or whether drugs or external irradiation had been administered in addition. The sections of tissue were not presented in order of the size of the dose of I^{131} (see Table I, Pathologist's Opinion, 2).

In the third and fourth studies, all the sections of both irradiated and non-irradiated tissues were again thoroughly mixed and presented to the pathologist without any clinical information (see Table I, Pathologist's Opinion, 3 and 4).

To recapitulate, in Study 2 the pathologist's opinions were on tissues he knew to have been irradiated, whereas his opinions in Studies 1, 3, and 4, identically performed test-retest studies, were on mixed irradiated and non-irradiated tissues. However, although the latter tests were identically performed, it will be recognized that the pathologist had been affected by the second study of known irradiated tissues. In addition, he knew the results of the second study after it had been completed.

Results: In Table I the data are arranged in order of total oral dose of I^{131}, since it is to be expected that, as the dose becomes larger, the effects of irradiation will be more pronounced and more easily recognized. It may be observed that this correlation does exist: those tissues which the pathologist selected most consistently as showing changes which he believed to be the effect of irradiation actually were those from patients who had received the larger doses.

There were 16 readings on the 4 cases that received more than 15 mc of I^{131}; of these, 15 were positive (94 per cent) and only 1 negative. There were 15 readings on the 4 cases that received between 7 and 10 mc, and of these, only 5 were positive (33 per cent). Of the 47 readings on the 12 irradiated cases that received less than 7 mc of I^{131}, only 7 were positive (15 per cent). Four of these 7 positive readings were in the first study.

The readings on Case 21 deserve comment, since 3 of the 4 were positive, although this patient had received only 0.94 mc of I^{131}. The changes in this section of tissue were probably due to causes

TABLE III: CONSISTENCY OF PATHOLOGIST'S OPINIONS

	Study (No.)	Number of Comparisons	Agreements No.	Agreements %	Disagreements No.	Disagreements %
		Study 1 Included				
Non-irradiated Tissue	1, 3, 4	57	51	89	6	11
Irradiated Tissue	1, 2, 3, 4	114	91	80	23	20
All Tissue	1, 2, 3, 4	171	142	83	29	17
		Study 1 Omitted				
Non-irradiated Tissue	3, 4	19	18	95	1	5
Irradiated Tissue	2, 3, 4	60	50	84	10	16
All Tissue	2, 3, 4	79	68	86	11	14

other than irradiation. Or it is possible that they may have been the result of irradiation, since, although the oral dose was small, there might have been a concentration of radioiodine in the particular tissues from which the section was taken.

On the 19 non-irradiated cases there were 57 readings, of which only 3 were positive (5 per cent).

II. ANALYSIS OF RELIABILITY AND CONSISTENCY OF PATHOLOGIST'S OPINIONS

The data in Table I permit an analysis of the intra-individual variation of opinion of the pathologist in the test-retest studies.

Two definitions for false positive and false negative were adopted:

Definition 1: Since Study 2 was of known irradiated tissues, a positive reading on a case in this study was used as a criterion for the presence of recognizable radiation effect for that case. A negative reading in Studies 1, 3, and 4 on those tissues called positive in Study 2 was a false negative. A positive reading in Studies 1, 3, and 4 on tissues called negative in Study 2 was a false positive.

Definition 2: On each case, a majority of the readings were either positive or negative. A reading different from this majority was called false.

If a tissue had not been irradiated (Cases 1–19) and was given a positive reading by the pathologist, this was always an error, or a false positive. However, a tissue which had been irradiated may have received so small a dose that it produced no recognizable change in the tissue. For this tissue a negative reading was not an error but a correct statement about the tissue on the basis of the definitions for false positive and false negative.

The data on false negatives and false positives are presented in Table II. First, all four studies were considered; then Study 1 was eliminated and only Studies 2, 3, and 4 were considered. During Study 1 the pathologist was at a disadvantage, both because it was the first study and because he did not fully realize that it was part of a test-retest investigation. Analysis of the data on both bases indicates whether this disadvantage affected the percentage of false positives and false negatives.

On the basis of either of the definitions used, the percentage of false negatives always exceeds the percentage of false positives. When Study 1 is not included and only Studies 2, 3, and 4 are used for analysis, the percentage of false negatives becomes even larger and the percentage of false positives even smaller.

The data in Table I also permit an analysis of the consistency of the pathologist's opinions. His opinion on a case in Study 1 may agree with those on the same case in Studies 2, 3, and 4, or may disagree with one or more of them. His opinion on a case in Study 2 may agree or disagree with those in Studies 3 and 4, etc. Table III presents the data on the consistency of the pathologist's opinions on irradiated and non-irradiated tissues, both including and excluding Study 1.

From Table III it can be seen that there is greater consistency of opinions on the non-irradiated tissues than on the irradiated tissues. Also, there is greater consistency of opinions when the first study is excluded. One explanation is that the pathologist became more conservative in his opinions as he continued the studies.

Moreover, he was influenced by the second study of known irradiated tissues, and, in addition, by his knowledge of the results of the second study upon its completion.

Of the 39 cases, there were 3 on which all 4 opinions were positive (Cases 36, 37, and 39), and 4 on which a majority of opinions were positive (Cases 21, 32, 33, and 38). It is of importance that in these test-retest studies the pathologist was able to select with considerable certainty those tissues that had not been irradiated, and similarly those irradiated tissues that had received the largest doses of I^{131}. This gives credence to the conclusion that *those tissues which the pathologist consistently and reliably chose as displaying evidence of irradiation actually had changes due to that cause.* The changes in the tissues on which all 4 opinions were positive were studied histologically and are described below. All of the changes described were the result of severe injury.

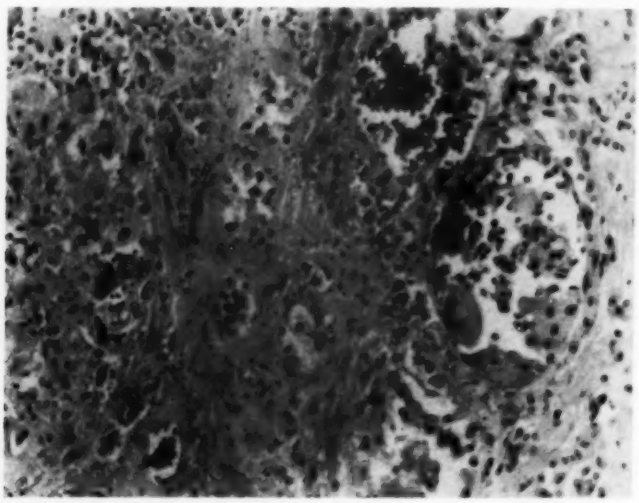

Fig. 1. Case 39. Acute, severe radiation damage, twenty-four days after approximately 47.4 mc of I^{131}. (The total dose was 52.18 mc. of I^{131}.) Acute necrosis of thyroid epithelium associated with subacute inflammatory infiltration; few thyroid follicles remaining. This patient had the clinical signs of acute radiation thyroiditis prior to thyroidectomy. Hematoxylin and eosin stain. ×160.

III. DESCRIPTION OF HISTOLOGIC CHANGES ATTRIBUTED TO RADIATIONS FROM I^{131}

One lesion (Case 39), early and acute, was characterized by severe, diffuse degeneration and necrosis of thyroid epithelium, with disruption of most follicles (Fig. 1). This reaction closely resembled the earlier changes observed in the thyroid glands of rats treated with I^{131} (5). Some portions of the thyroid tissue appeared infarcted and displayed intrafollicular and interstitial hemorrhage. Many of the remaining epithelial cells were enlarged and displayed abundant vacuolated cytoplasm. Intrafollicular proliferation of multinucleated cells was observed occasionally Little colloid remained, and the follicular spaces contained fibrin and desquamated epithelial cells. There were increased amounts of mucoid perifollicular fibrous tissue which was diffusely infiltrated with lymphocytes and neutrophilic leukocytes. Relatively few inflammatory cells were observed in the degenerating follicles. A few small arterioles were occluded by endothelial swelling. The walls of several small veins were infiltrated with lymphocytes.

The two other lesions recognized with certainty (Cases 36 and 37) displayed

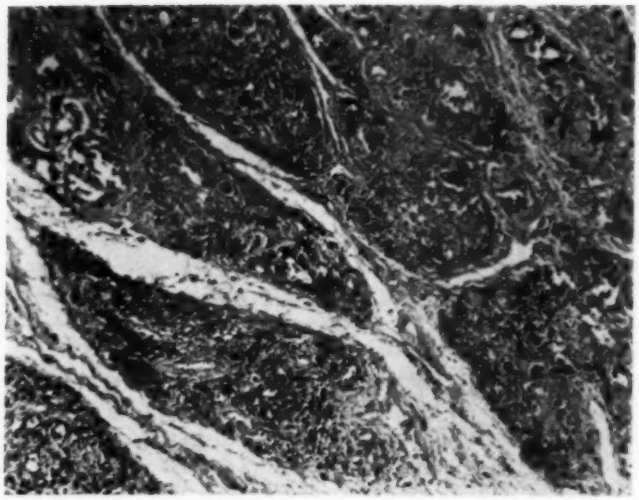

Fig. 2. Case 36. Chronic radiation damage. This patient received 15.68 mc of I^{131} over a period of 547 days. The last dose, 3 mc of I^{131}, was given thirty-five days before removal of tissue for histologic study. Atrophy of lobules and follicles associated with extensive intralobular fibrosis. Hematoxylin and eosin stain. ×80.

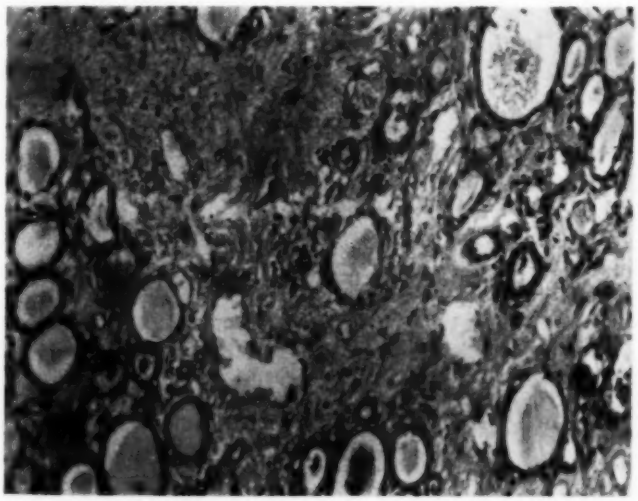

Fig. 3. Case 37. Chronic radiation damage, 298 days after the last administration of I^{131} (21 mc of I^{131} administered during a period of 235 days). Small atrophic follicles containing little colloid; considerable perifollicular scarring, with mild infiltration with chronic inflammatory cells. Hematoxylin and eosin stain. ×160.

histologic patterns which were similar to each other (Figs. 2 and 3). The lobules were atrophic. Each gland was characterized by moderate, diffuse, perifollicular and interlobular fibrosis. Small collections of lymphocytes and plasma cells were found in this connective tissue. Small, discrete lymphoid follicles were observed in only one gland. The follicles were small and appeared atrophic; the

epithelial cells comprising the follicles were cuboidal or low-columnar and were moderately pleomorphic. The nuclei tended to be hyperchromatic, and the amounts of cytoplasm were increased. The colloid was pale or granular, but many follicles were devoid of this substance. Two of the sections of tissue contained small encapsulated nodules, composed of enlarged follicles filled with colloid. Although these glands were obviously atrophic and scarred, no vascular lesions were observed.

The various alterations of epithelium and stroma in the irradiated glandular tissues which have been described may be observed also in non-irradiated thyroid glands. Thus epithelial degeneration or necrosis, follicular and lobular atrophy, cellular pleomorphism and eosinophilia, fibrosis and lymphoid infiltration may occur singly or in certain combinations in a variety of thyroid diseases. *However, these three irradiated thyroid tissues displayed a combination of lesions and a histologic pattern which are unique and which do not occur in other thyroid disease processes.*

In the remainder of the irradiated tissues in this study, where effects of radiations from I^{131} were not detected with the same degree of certainty, the lesions observed may have resulted from radiation injury. Since the changes observed in these tissues (Hashimoto thyroiditis and interlobular fibrosis) occur occasionally during the course of toxic diffuse goiter, their relation to the I^{131} administered could not be determined with accuracy. Detailed descriptions of a variety of lesions observed in hyperplastic thyroid glands irradiated with I^{131} have been presented elsewhere (2).[5]

[5] Detailed microscopic descriptions and the findings of radioautographic studies in the work cited include 17 of the cases used in this paper. The case number which appears first is the case number used in this paper (see Table 1). The case number following in parentheses is that used in the study cited above: Case 20 (19), Case 21 (10), Case 22 (11), Case 23 (17), Case 24 (9), Case 25 (5), Case 28 (14), Case 29 (1), Case 30 (20), Case 31 (4), Case 32 (21), Case 33 (16), Case 34 (3), Case 35 (15), Case 36 (6), Case 37 (2), Case 38 (18).

IV. DIFFERENTIAL DIAGNOSIS BETWEEN EFFECTS OF RADIATIONS FROM I^{131} AND DISEASES OF THE THYROID

The injury of thyroid glandular tissue resulting from a large dose of I^{131}, when seen during its early, acute phase, has certain resemblances to lesions in acute or subacute thyroiditis of bacterial or other origin but differs from them in several respects. The lesion produced by irradiation with I^{131} is found in all parts of the gland and is more pronounced in and about the thyroid follicular epithelium. The secondary interstitial inflammation is less severe than in primary inflammatory disease. Vascular injury with thrombosis and infarction, which is pronounced in the irradiated gland, is unusual in acute thyroiditis. The intrafollicular proliferation of epithelium is minimal when compared to that occurring in subacute or giant-cell thyroiditis (6).

In some respects the late thyroid lesions resulting from large doses of I^{131} resemble those of hyperplasia of long duration, of chronic thyroiditis of the Hashimoto type, cretinism, myxedema, and aging.

Although fibrosis, lymphoid infiltration, and cellular pleomorphism and eosinophilia of the epithelial cells are frequently observed in hyperplasia of long duration, the lobular pattern shows little alteration, whereas in the irradiated tissues the lobular pattern is much less distinct. Moreover, the degree of follicular atrophy does not approach that observed in thyroid tissue irradiated with I^{131} when there is a long interval between irradiation and histologic study.

In chronic thyroiditis of the Hashimoto type (7), the connective tissue is often abundant, hyalinized, and in some stages of the disease is proliferating; in the tissue irradiated with I^{131} it is less plentiful and consists of condensed thyroid stroma. The lymphoid tissue is ordinarily more abundant in Hashimoto disease. Intrafollicular proliferation and reorganization of the thyroid epithelium with formation of small follicles are characteristic of the

Hashimoto process. Follicular size may be reduced to the same degree in the irradiated gland as in Hashimoto thyroiditis, but in the former the reduction of follicular size results from atrophy rather than intrafollicular reorganization.

In the atrophic glands of cretinism or myxedema, no lobular pattern remains. The epithelial cellular groups are atrophic and the cells frequently display pleomorphism and eosinophilia. The lymphocytic infiltration is minimal and focal, and the connective tissue present appears to represent condensed stroma rather than proliferating reacting connective tissue.

In aged persons, considerable follicular atrophy may be observed, occasionally associated with nuclear pleomorphism and cellular eosinophilia. Fibrosis, however, is usually minimal or absent.

Perifollicular fibrosis is conspicuous in the late lesion resulting from large doses of I^{131} and serves to differentiate this lesion from various other atrophic thyroid processes.

DISCUSSION

The approach employed in this investigation to the separation of irradiated from non-irradiated thyroid tissues by their histologic appearance results in a high certainty that the changes in the tissues described were actually the result of radiations from I^{131}. On the other hand, some of the tissues examined may have had evidence of such effects, but of lesser magnitude, which was not detected by this method. In other words, completeness of detection of histologic effects of irradiation was sacrified for sureness of assignment of their cause.

Test-retest studies on the reading of x-ray films have given some measure of intra- and inter-individual variations in interpretations of static data. In some of the papers describing such studies (3, 4, 11, 13, 14, 15), references were made to other investigations of a similar nature dealing with the determination of malnutrition in children, the need for tonsillectomy, etc. All reveal similar discrepancies between interpretations of the same data by the same individual and by different individuals at different times. It is not surprising, then, to find disagreement of a pathologist with himself in the field of thyroid pathology, further complicated by an attempt to identify changes which are the result of irradiation.

It is hoped that this study will stimulate other pathologists to carry out similar test-retest studies. Only in this fashion may the indispensable histologic criteria be identified which will warrant unbiased conclusions regarding changes caused by irradiation. The error of *post hoc* reasoning in ascribing certain lesions to irradiation can be minimized best by "blind" appraisals. An example of such a blind study is the frank and engaging paper by Cole (1), who described the various diagnoses of gastric lesions and divergent conclusions reached by highly competent pathologists following examination of identical slides.

SUMMARY

1. Histologic sections from the thyroid glands of 19 unirradiated patients with various thyroid diseases were thoroughly mixed with sections of tissue from the thyroid glands of 20 patients irradiated with I^{131}. Of these latter patients, all but one had toxic diffuse goiter. In 4 test-retest studies the pathologist (SL) attempted to select those sections of tissue showing changes that he believed to be the result of irradiation from those showing changes due to other causes. Studies 1, 3, and 4 were identically performed. In Study 2, when the pathologist was aware that all the sections of tissue presented to him had been irradiated, he attempted to select those showing changes that he believed to be the result of irradiation.

2. The pathologist recognized with considerable certainty the tissues of those patients who had not been irradiated (57 of 60 negative readings on 19 cases) and the tissues of those patients who had received more than 15 mc of I^{131} orally (15 of 16 positive readings on 4 cases).

3. There was less certainty of recognition of the effects of radiations from I^{131} in the tissues from patients who had received from 7 to 10 mc of I^{131} (5 of 15 positive readings on 4 cases).

4. There was considerable certainty about the *absence* of recognizable effects of radiations from I^{131} in tissues from patients who had received less than 7 mc of I^{131} (40 of 47 negative readings on 12 cases).

5. The pathologist became more cautious as he continued the studies. In later tests (Studies 3 and 4) he was less willing to assign an effect to irradiation than he was in the first test. His opinions had been affected also by the second study of known irradiated tissues and his knowledge of the results of that study.

6. The percentage of false negative readings (14.8 to 37.5 per cent) exceeded the percentage of false positive readings (1.3 to 6.5 per cent).

7. The consistency of the pathologist's opinions on the non-irradiated tissues (89 to 95 per cent agreement) was greater than on the irradiated tissues (80 to 84 per cent agreement).

8. As a result of the first part of the investigation, the series of test-retest studies and the subsequent analyses of the reliability and consistency of the results of these studies, sections of tissue for 3 cases (Cases 36, 37, and 39) were found displaying lesions attributed to the effect of irradiation with I^{131}. (All four of the pathologist's opinions were positive.) These sections of tissue were studied histologically and carefully described. The changes observed were all pronounced.

The tissue obtained twenty-four days after the largest dose of I^{131} (Case 39) showed acute epithelial necrosis associated with subacute inflammation. The lesions observed in the tissues from the patients who received smaller doses (Cases 36 and 37), which were studied after a great interval of time, were characterized by follicular atrophy and extensive perifollicular and interlobular fibrosis. Nodular regeneration was observed in these tissues.

A description is given of the histologic characteristics in the three tissues which distinguish the effects of irradiation from those due to other causes.

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SUMARIO

Estudios con Radioyodo. V. Validez de la Determinación Histológica de las Alteraciones Producidas por la Radiación con I^{131} en el Tiroides

Mezcláronse cortes histológicos de los tiroides de 19 enfermos que padecían de distintas afecciones de dicha glándula, pero que no habian recibido irradiación, con cortes de tejido tiroideo que habia sido irradiado con I^{131}, principalmente por bocio difuso tóxico. En cuatro estudios sucesivos, trató el patólogo de seleccionar los cortes que revelaban alteraciones imputables a la irradiación de los que tenían alteraciones debidas a otras causas.

Reconoció el patólogo con considerable certeza los tejidos de los enfermos que no habían sido irradiados y los de los enfermos que habían recibido más de 15 mc. de I^{131} oralmente. Fué menos cierto el reconocimiento de los efectos de las radiaciones de I^{131} en los tejidos de los enfermos que habían recibido de 7 a 10 mc. de I^{131}. Fué considerable la certeza en cuanto a la *ausencia* de efectos reconocibles de las radiaciones de I^{131} en los tejidos de los enfermos que habían recibido menos de 7 mc. El porcentaje de lecturas seudonegativas excedió el de las seudopositivas.

La conformidad de los dictámenes del patólogo sobre los tejidos no irradiados (acuerdo de 89 a 95 por ciento) fué mayor que sobre los irradiados (acuerdo de 80 a 84 por ciento).

Los cortes de tejido de 3 casos mostraron alteraciones debidas indudablemente a la irradiación con I^{131}. El tejido obtenido a los veinticuatro dias de la dosis máxima de I^{131} reveló necrosis epitelial aguda asociada con inflamación subaguda. Las lesiones observadas en los tejidos de los enfermos que recibieron dosis más pequeñas, que fueron estudiadas al cabo de un plazo mayor de tiempo, se caracterizaron por atrofia folicular y extensa fibrosis perifolicular e interlobular. En estos tejidos observóse regeneración nodular.

Se ofrece una descripción de las características histológicas de los tres tejidos, que diferencian los efectos de la irradiación de los debidos a otras causas, tales como tiroiditis, cretinismo, mixedema y envejecimiento.

Absolute Calibration of a Cobalt-60 Gamma-Ray Beam

S. GENNA, M.S., and J. S. LAUGHLIN, Ph.D.

THIS REPORT describes the calorimetric determination of the amount of energy in the collimated gamma-ray beam from a cobalt-60 source, and the amount of ionization produced by this beam under specified conditions. These measurements experimentally relate absorbed dose and quantity of radiation. Comparison of this experimentally determined relationship is made with the calculated relationship predicted by theory, permitting critical evaluation of the theory under the specified conditions.

The calorimetric determination of the quantity of radiation will be described in detail. Measurements with two secondary standards were made for correlation with the calorimetric results. The first standard is the roentgen as measured with a 25-r Victoreen thimble chamber calibrated at the National Bureau of Standards with a cobalt-60 gamma ray source. The second standard is a polystyrene wall extrapolation chamber measurement of cavity ionization.

X-ray and gamma-ray radiations are usually measured in terms of the roentgen. The roentgen has assumed a dual role in radiology through its use as a measure of dose as well as a measure of output. It is not a direct measure of either energy flux or dose but can be related to both by calculation or experiment. The correlation of the roentgen with our calorimetric determination will be evaluated both theoretically and experimentally.

It is possible to calculate the amount of cavity ionization to be expected in a chamber of known dimensions and materials exposed to a calibrated beam. An extrapolation chamber with polystyrene walls was exposed to the same beam which was calorimetrically calibrated, and the absolute magnitude of the cavity ionization was determined. This measurement permits an evaluation of cavity ionization theory.

The first phase of the experimental investigation is the absolute measurement of the quantity of radiation (ergs/cm.^{2}) in the Memorial Center telecobalt beam. The calorimetric apparatus used in the measurements is a modification of the calorimeter used by Laughlin and Beattie with 22.5-Mev x-rays (3, 4).

CALORIMETER APPARATUS

A single lead-tungsten absorbing cylinder, illustrated in Figure 1, is suspended in a vacuum chamber for use as the energy absorber for the telecobalt gamma-ray beam. The absorber is suspended with nylon threads through eyelets attached to the roof of the vacuum chamber and accurate alignment is made possible by worm-screw adjustments.

The absorber is constructed in three sections. The center section, or socket, consists of a silver-plated cylindrical brass shell filled with lead. The two end sections, or plugs, are machined from "Hevimet" tungsten alloy. After mounting the thermistor in one plug and the heater element in the other, the separate elements are screwed together and soldered at the joints to insure good thermal conductivity.

A Western Electric No. 12A rod-type thermistor is used as the temperature-sensitive element. The No. 12A thermistors are about 3 cm. long and 3 mm. in diameter. They have a high negative temperature coefficient of about 3.8 per cent/° C. and a total resistance of about 10,000 ohms at 26° C.

A rectangular groove, 4 cm. long, 4 mm. wide, and 4 mm. deep, is cut in the rear

[1] From the Division of Physics and Biophysics, Sloan-Kettering Institute, New York, N. Y. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5–10, 1954. This work was supported in part by the Atomic Energy Commission, AT (30-1) 1451.

tungsten plug for the thermistor rod. The heavy electrodes of the thermistor were removed and replaced with insulated 36 B&S gauge copper wire. In order to obtain good thermal contact between the thermistor and the tungsten plug, one end of the thermistor is securely soldered to the tungsten. The remainder is insulated with a thin sheet of Teflon. The entire thermistor is then imbedded in the rectangular groove with Wood's metal.

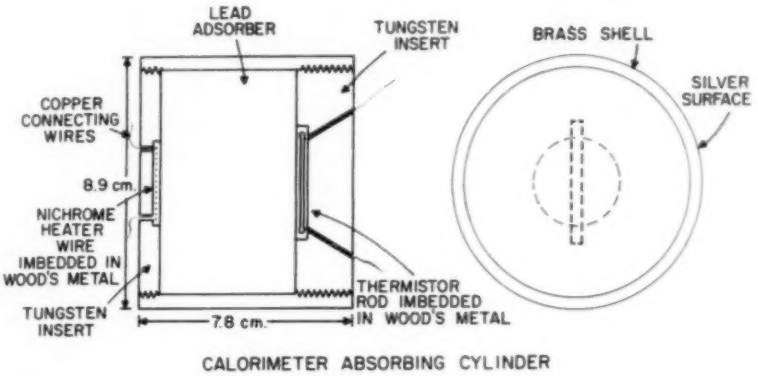

Fig. 1. Construction of the calorimeter cylinder used to absorb cobalt-60 gamma rays.

An insulated Nichrome wire heating element, imbedded in Wood's metal within the front plug, serves to introduce a known amount of energy for calibration. Enameled insulated Nichrome wire is soldered at one end to the tungsten plug and at the other end to 36 B&S gauge enameled copper wire. A cylindrical well machined in the "Hevimet" receives the Nichrome heating element as well as a few turns of copper wire. Wood's metal serves to secure the wire to the tungsten plug with good thermal contact.

Thermal isolation of the absorber cylinder is the prime prerequisite for a suitable x-ray calorimeter. A schematic diagram of the calorimeter construction is given in Figure 2. The two cylinders shown in the diagram are used independently of each other. One cylinder is used for the cobalt gamma-ray exposures, the other for betatron x-ray exposures.

The surface of the cylinders and the inside wall of the vacuum chamber are silver-plated and finished to a high polish in order to minimize radiation heat transfer. A thin aluminum baffle surrounds the sides and ends of the cylinder in order to dampen radiation heat transfer effects of temperature fluctuations in the chamber walls.

The calorimeter vacuum chamber is immersed in a thermostatically controlled bath of rapidly circulating water. A centrifugal pump and heat exchanger unit continuously circulates and cools the water bath. Cooling is effected by means of a water-cooled copper coil. A mercury thermoregulator controls two knife heaters immersed in the water bath.

Optimum temperature regulation is obtained by placing both heaters immediately upstream from the thermoregulator. The water bath temperature oscillates about the equilibrium temperature with an amplitude of approximately 0.005° C. and a period of twenty seconds. The aluminum baffle, interposed between the vacuum chamber walls and the absorbing cylinder, serves to reduce the effective environmental fluctuations in ambient temperature as seen by the calorimeter absorber. The baffle was effective in eliminating noticeable temperature oscillations in the absorber due to oscillations in water bath temperature.

Earlier calorimeters have been of the dual-cylinder type. Two identical cylin-

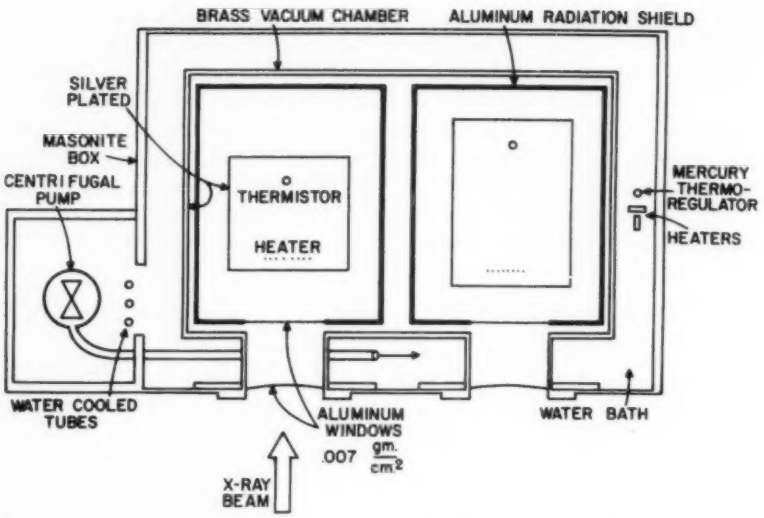

Fig. 2. Horizontal cross section of the calorimeter construction.

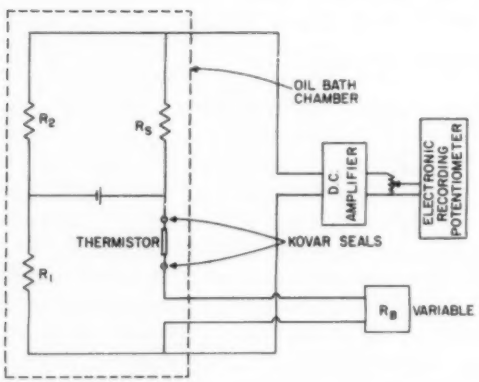

Fig. 3. Diagram of bridge circuit. Fixed resistors are 10,000 ohm precision wire wound resistors. A Leeds & Northrup No. 4755-S A.C. resistance box is used to balance the bridge. The bridge unbalance is amplified by a Liston-Becker chopper amplifier and continuously recorded on a Brown electronic potentiometer.

ders with their respective thermistors on opposite arms of a Wheatstone bridge were suspended in the same vacuum chamber. One cylinder could thus be used as an x-ray absorber, while the other compensated for variations in ambient temperature and the energy dissipated in the thermistor by the bridge current. It is felt by the authors that the single absorber system represents an improvement over the older variety under these conditions where the bridge current is low. With two cylinders, one must be certain that they are sufficiently matched in temperature sensitivity and thermal environment to operate in conjunction. With small fluctuations in ambient temperature, it is difficult to ascertain whether or not the environmental fluctuations and the time constants are sufficiently similar for ideal operation of the dual cylinder system. In addition to the above considerations, one obvious advantage of the single cylinder system is that it reduces the number of variables and simplifies the apparatus.

Electrical connections to the thermistor and heater coil are made through Kovar seals on the roof of the chamber. The thermistor is connected as one arm of a Wheatstone bridge. The remaining elements of the bridge circuit are shown in Figure 3. All the elements except the control resistance box are immersed in an oil bath on the lid of the chamber in order to eliminate variable thermal E.M.F.'s. The junctions of the control resistance box are insulated to eliminate rapid tempera-

ture fluctuations caused by room drafts.

The bridge unbalance E.M.F. is amplified by a d.c. chopper amplifier and recorded continuously with an electronic potentiometer. Since the voltage output of the bridge is directly proportional to the resistance change in the thermistor arm, the bridge can be operated off balance to yield a continuous record of the resistance change of the thermistor.

In practice, the bridge is rebalanced periodically. This periodic rebalancing serves to calibrate the potentiometer scale in ohms/division as well as to maintain bridge operation in its most accurate region. Continuous recording is particularly useful in recording small resistance changes when the absorbing cylinder is in quasi-equilibrium with its surroundings.

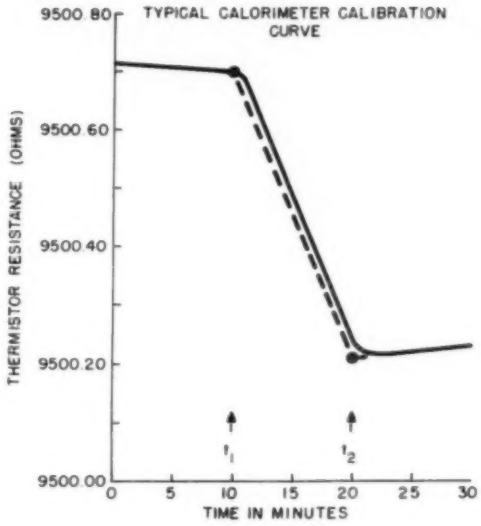

Fig. 4. Plot of typical data taken during a calorimeter calibration run. A measured amount of energy is dissipated in the absorber during the time interval $t_2 - t_1$. The dotted line indicates the theoretical thermistor resistance versus time that would be obtained if there were no thermal barriers within the radiation absorber. The effect of thermal loss on the net resistance change can be evaluated from the drift rate before and after energy input.

CALIBRATION OF CALORIMETER APPARATUS

The heater resistance embedded in the absorbers, as mentioned earlier, serves to introduce the known energy standard for calibration. Copper lead connections made inside the cylinder to the heating coil are brought outside the vacuum chamber through Kovar seals. A constant current through the heater is employed for calibrating the instrument. The energy input is determined from the constant potential drop across the predetermined heater coil resistance. The potential drop is measured with a Leeds & Northrup type K2 potentiometer during current input.

A typical calibration curve for the telecobalt calorimeter is given in Figure 4. Initially the calorimeter absorber is allowed to reach a quasi-equilibrium state in which the difference in temperature between the absorber and ambient is less than 0.01° C. The heat loss (or gain) rate by the cylinder is indicated by the constant drift.

At a time t_1, current is introduced through the heating coil and the heating rate of the absorbing cylinder gradually increases until a constant heating rate is achieved. At a time t_2, the current is turned off and the calorimeter returns to a constant drift rate. The drift before and after each run differs by a small amount due to the absolute temperature change of the cylinder. The actual curve analysis depends upon a single extrapolation of the final straight line drift. Repeated experiments and observations of drifts over day-long periods demonstrate linear drift characteristics.

The dotted line in Figure 4 indicates the theoretical time-temperature curve that would be obtained were there no time lag in heat transfer through the cylinder and thermistor. A simple method of analysis is to extrapolate the final drift to a time t_2. By joining the drift points at t_1 and t_2, the ideal instantaneous curve is readily obtained. The drift characteristics are of primary importance in determining the extent of accuracy obtainable. The total resistance change is readily obtained from this curve as

$$\Delta R = R_2 - R_1 - \left\{\left(\frac{dR}{dt}\right)_1 + \left(\frac{dR}{dt}\right)_2\right\} \frac{t_2 - t_1}{2} \quad (1)$$

where

t_1 = time at which current is turned on . . . min.
t_2 = time at which current is turned of . . . min.
R_1 = resistance at time t_1
R_2 = resistance at time t_2 on the theoretical instantaneous heat transfer curve

$\left(\frac{dR}{dt}\right)_1$ = drift rate before energy input

$\left(\frac{dR}{dt}\right)_2$ = drift rate after energy input

A series of 21 calibrations were performed with the telecobalt absorber, yielding a sensitivity value of

$$\frac{dR}{dE} = 0.351 \frac{\text{ohms}}{\text{joule}} \quad (2)$$

with a standard deviation of ±0.005 ohms/joule. The results were found to be independent of the energy input rate used for the calibrations.

IRRADIATION WITH TELECOBALT GAMMA-RAY BEAM

The energy in a collimated beam from the Memorial Center telecobalt unit was measured. The cobalt-60 source is in the form of a number of small pellets contained in a cylindrical steel shell. The shell has a diameter of 1.2 inches and a length of 1.3 inches. Self-absorption of the cobalt-60 radiation and filtration by the steel shell reduce the effective strength of the source by about 40 per cent.

A 1-inch diameter lead collimator with its exit diaphragm 47 cm. from the source was used for all energy measurements. The beam was admitted into the calorimeter through two thin aluminum foil windows (0.007 gm./cm.²). The calorimeter was positioned so as to locate the absorber along the beam axis, as shown in Figure 5. The geometrical beam penumbra diameter was about 4.5 cm. at the face of the absorber. This arrangement

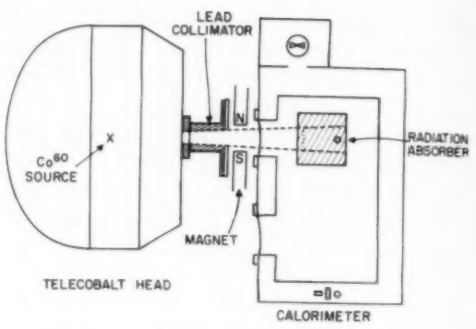

Fig. 5. Diagram showing the position of the calorimeter in front of the telecobalt unit. The radiation absorber front surface is located at 66 cm. from the cobalt-60 source. The geometrical beam penumbra diameter is about 4.5 cm. at the face of the absorber.

results in negligible side-scatter loss through the walls of the absorber and insures the total absorption of the beam.

In order to remove any electrons that might be projected in the collimator, a magnet with a field strength of approximately 10,000 gauss was positioned with its field perpendicular to the beam during irradiation of the calorimeter absorber. Ten-minute irradiations were employed. The thermistor resistance change for 19 absorber irradiations was computed as described earlier. The resultant value of resistance change per minute is

$$\frac{dR}{dt} = 0.0470 \frac{\text{ohms}}{\text{min.}} \quad (3)$$

with a standard deviation of ±0.0006 ohms/min.

It is pertinent to convert the resulting resistance change into the temperature change of the absorber. Since the sensitivity of the thermistor is approximately 380 ohms per degree centigrade, the rate of temperature change is about

$$\frac{dT}{dt} = 1.24 \times 10^{-4} \pm 1.6 \times 10^{-6} \frac{^\circ\text{C.}}{\text{min.}} \quad (4)$$

A few minor corrections for back-scattered and transmitted energy must be made before the final value of the energy output of the collimated beam is determined. The absorber cylinder dimensions were sufficiently large to reduce the side-

scatter and transmitted energy corrections to a negligible magnitude. Estimates of the loss of energy due to side-scatter and transmission were made from measurements with a cylindrical ionization chamber. Integrated ionization measurements laterally around the absorber and in the rear of the absorber yielded an energy loss from the absorber of 0.25 per cent due to side-scatter, and 0.45 per cent energy transmitted. In the corrections, it was assumed on theoretical grounds that the ergs/r-cm.^{2} for the lower energy scattered quanta is of the same order of magnitude as that of the higher energy quanta. The back-scattered energy albedo was taken as 0.1 per cent according to the theoretical computations of Hayward and Hubbel (2).

Combining the results in Equations 2 and 3 with the above corrections, the total energy output rate becomes

$$\frac{dE}{dt} = 0.135 \pm 0.002 \frac{\text{joules}}{\text{min.}} \quad (5)$$

SECONDARY STANDARD COMPARISON— VICTOREEN THIMBLE CHAMBER

A suitable secondary standard for the total energy output of the beam is the integrated r-cm.^{2}/min. along a plane perpendicular to the axis of the gamma-ray beam. If the energy absorbed in air is neglected, any plane intercepting the beam will have the same rate of energy flow through it. Similarly the integrated r-cm.^{2}/min. is a constant of the beam. The plane need not be perpendicular for the above to hold but is chosen as such for convenience.

The integration was performed in two

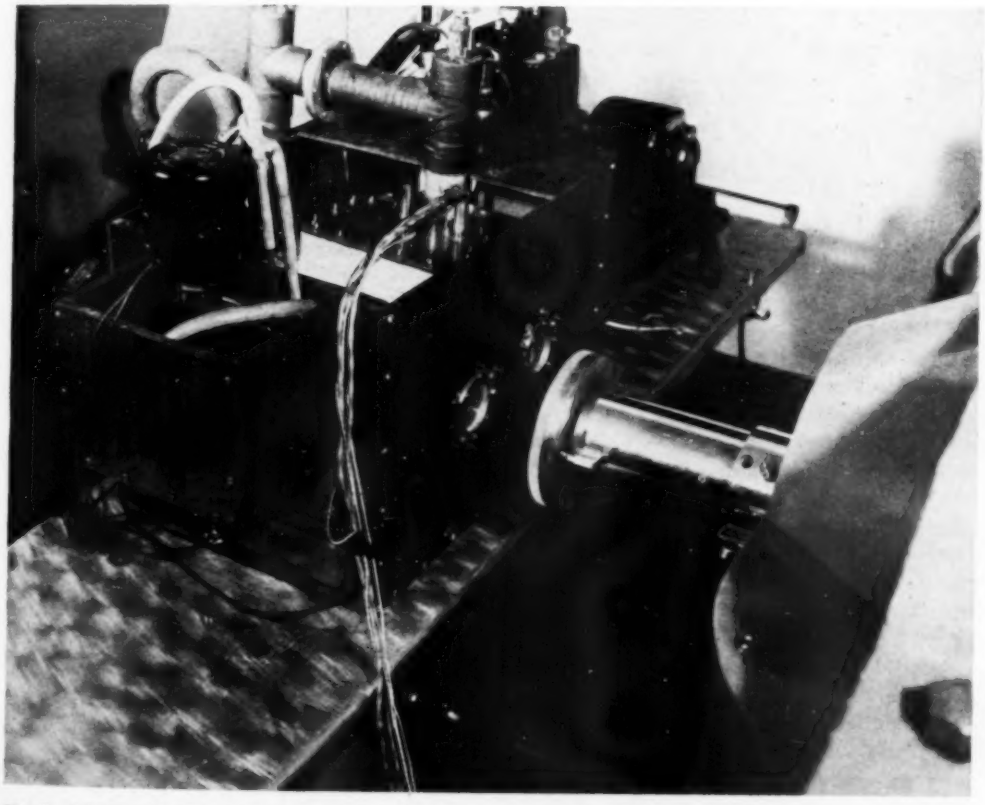

Fig. 6. Photograph of the calorimeter in position in front of the Memorial Center telecobalt unit. A magnet, not shown in the photograph, is positioned as shown in Fig. 5.

steps. The number of roentgens per minute was first measured at 120 cm. from the source along the central axis. The measurement was performed with a 25-r Victoreen thimble chamber previously calibrated at the National Bureau of Standards. A 3-mm.-wall phenol-formaldehyde (Catalin) cap was fitted over the thimble during calibration in order to measure the

$$\frac{\text{r-cm.}^2}{\text{min.}} = \frac{2\pi \int_0^R I(r).r.dr}{I_0} \times \frac{\text{r(Victoreen)}}{\text{min.}} \quad (6)$$

where

$I(r)$ = relative radial intensity
I_0 = central axis relative intensity
R = geometrically projected radius of calorimeter absorber

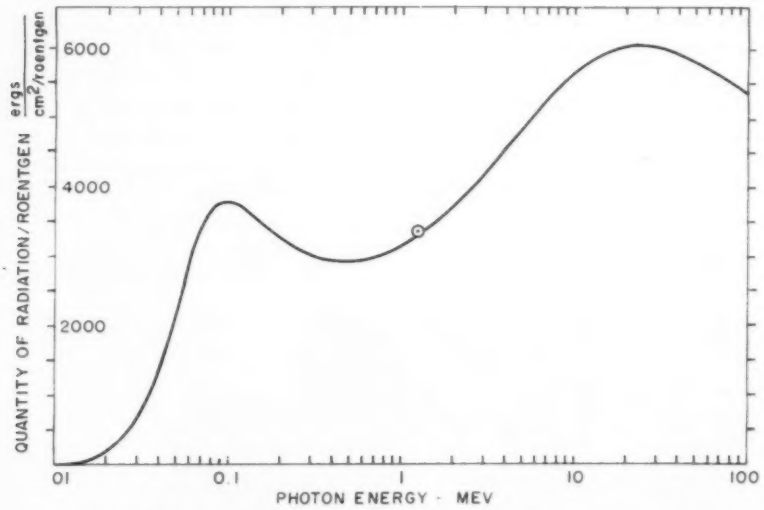

Fig. 7. Plot of the theoretical value of the quantity of radiation per roentgen. The quantity of radiation per roentgen is computed from the true portion of the absorption coefficients of G. R. White (8). It is assumed in the computation that $W = 34.1$ and is independent of the energy of the ionizing electrons. ⊙ indicates calorimetric experimental value:

cavity ionization under equilibrium conditions. The method used in its calibration at the National Bureau of Standards will be discussed later.

In order to obtain the integrated r-cm.²/min., the relative radial intensity distribution is measured in the same plane as the central axis Victoreen thimble chamber measurements. A 3-mm. cube anthracene crystal detector was used for the relative intensity survey. Readings were taken along the horizontal and vertical diameters of the beam. The beam is radially symmetrical to about 1 per cent of the measured relative intensity values. The average values of the four radial intensity distributions were used for the graphical integration.

The calculation yields an integrated value of 401 ± 13 r-cm.²/minute, assuming an N.B.S. Victoreen calibration accuracy of ±3 per cent, an experimental accuracy with the Victoreen chamber of ±1 per cent, and an anthracene crystal intensity distribution accuracy of ±1 per cent.

Combining the result of Equation 6 with the above, the resultant *quantity of radiation per roentgen* in the gamma-ray beam from the Memorial Center telecobalt unit is

$$\frac{Q}{r} = 3370 \pm 130 \text{ ergs/cm.}^2\text{-r} \quad (7)$$

THEORETICAL QUANTITY OF RADIATION

The computed quantity of radiation per roentgen is given in Figure 7. The func-

tion has been calculated from values of the true portion of the mass absorption coefficients (8) for x-rays in air. It is assumed in the computation that the average energy dissipated per ion pair formed in air is independent of the energy of the ionizing particle and is equal to 34.1 ev. If the average energy of cobalt-60 gamma rays is 1.25 Mev, the true portion of the mass absorption coefficient for air is equal to 0.0268 cm.^{2}/gm. The corresponding theoretical quantity of radiation per roentgen is equal to 3280 ergs/cm.^{2}

Absorption and scattering of the gamma radiation within the cobalt source itself result in a degradation of the emitted photon energies. An estimation of the degradation of the emergent gamma ray beam yields an absorption coefficient of 0.0271 cm.^{2}/gm. The corresponding theoretical quantity of radiation is equal to 3250 ergs/cm.^{2}-r.

A comparison of the experimental results of Equation 7 with the computed theoretical value of the quantity of radiation per roentgen requires an examination of the basis of the calibration of the Victoreen thimble chamber by the National Bureau of Standards. Our Victoreen thimble chamber, with the same additional Catalin cap mentioned above, was calibrated at the National Bureau of Standards against a standard cavity chamber in a cobalt-60 gamma-ray beam. The standard chamber was in turn calibrated with a known quantity of radium gamma radiation filtered with 0.5 mm. of platinum. The value of 8.4 r/hour at 1 cm. from a milligram of radium filtered by 0.5 mm. of platinum was used by the National Bureau of Standards for the calibration of their standard cavity chamber and consequently is the basis of their calibration of our Victoreen thimble chamber.

ABSORBED DOSE IN AIR

As a measure of the ionization charge produced in air, the roentgen is equivalent to 773.4 esu/gm. of air. The absorbed dose in air per roentgen is given by the product of the ionization charge per gram of air per roentgen and the average energy expended per esu of charge produced in air by the ionizing particles. If average energy dissipation of 34.1 ev/ion pair is employed, the absorbed dose in air per roentgen is computed to be 88.0 erg/gm.

The value of the absorbed dose in air can be computed from the experimental value of the quantity of radiation per roentgen as given in Equation 7. The energy of the cobalt-60 gamma rays emitted through the collimator is degraded and the corresponding true portion of the mass absorption coefficient is equal to 0.0271 cm.$^{-1}$. The value of the absorbed dose in air corresponding to one roentgen, as determined from the product of our calorimetric measurements (ergs/cm.^{2} N.B.S. roentgen) and the true portion of the absorption coefficient for air, is equal to 91.2 ergs/gm.-air.

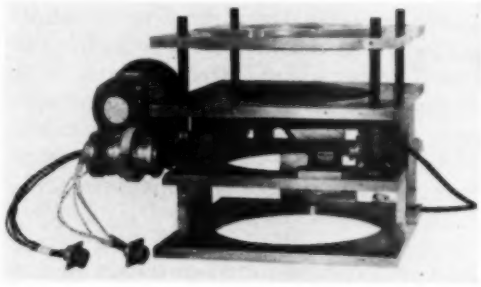

Fig. 8. Photograph of the extrapolation chamber. Radiation is incident upon the upper wall of the chamber. The polystyrene chamber walls are supported by Lucite rings, which are mounted in holes of 23-cm. diameter cut into the aluminum support plates. The upper aluminum plate moves on four precision machined screws having a screw pitch of 0.05 cm./revolution. Additional thicknesses of wall material can be added to the upper or lower chamber walls as desired. The control box is in the control room during irradiation.

EXTRAPOLATION CHAMBER APPARATUS

In order to correlate the calorimetric results with cavity ionization chamber measurements, an extrapolation chamber was constructed. The chamber is illustrated in Figure 8. Four precision machined screws, having a pitch of 2 revolutions per millimeter, support the top movable frame of the chamber. An interlocking gear system, driven by a low-speed

motor, actuates the four screws simultaneously. A Selsyn system geared to the screws drives a revolutions counter in a control box, permitting accurate adjustment of the plate separation outside of the irradiation room. The revolutions counter is geared to indicate 10 counts per revolution of the machine screws.

Two parallel chamber walls of any material are easily mounted on the aluminum frames. In this experiment the chamber walls are machined of polystyrene. The upper wall of the chamber consists of a polystyrene disk 14 cm. in diameter and of variable thickness. The thickness used for the absolute measurements is 0.726 gm./cm.^{2} The inner surface of the upper wall, coated with a uniformly thin layer of colloidal graphite (Aquadag), serves as a movable high-voltage electrode. The lower wall of the chamber, machined from polystyrene, is 2.54 cm. thick. The chamber frame is so designed that any additional desired thickness of absorber may be added below this lower plate to insure maximum scatter contribution. Aquadag coated on the inner surface of the lower wall forms the collecting electrode and the guard ring. The collecting electrode diameter is 3.011 cm. as measured to the center of a circular groove (0.006 cm. wide) insulating the electrode from the guard ring. The collecting electrode diameter and the groove width were measured with a traveling microscope.

The chamber walls are set parallel to each other with tripod screw adjustments. Precision machining and micrometer alignments assured uniform spacing of the chamber electrodes to within 0.01 mm. The electrode separation was calibrated as a function of the revolutions counter reading with a series of micrometer measurements. The calibration yields a value of 20 counts per millimeter, which is consistent with the precision machining of the lead screws. Though back lash was negligible, it was completely avoided by taking all measurements with the plate traveling in the same direction. The electrode separation as a function of the revolutions counter calibration is reproducible to within 0.01 mm.

EXTRAPOLATION CHAMBER MEASUREMENTS

Ionization currents were measured with the lower electrode of the chamber positioned at 75 cm. from the source with its center on the central axis of the beam. The magnet, mentioned earlier, was positioned with its field perpendicular to the gamma-ray beam. The collimated beam has a uniform intensity distribution over an area of about 7 cm. diameter. The intensity falls off to approximately 1 per cent of the maximum beam intensity at about 20 cm. diameter. A broad beam was used in order to compensate for the loss of ionization due to electrons escaping through the sides of the parallel plate chamber. Under broad-beam conditions, the loss of electrons is compensated for by electrons returning into the collecting volume from the irradiated guard ring region.

A null type electrometer circuit is used to measure the chamber current as a function of the revolutions counter reading. The electrometer circuit is calibrated against a standard current source that was previously calibrated at the National Bureau of Standards. A constant saturation field intensity of 10 volts/mm. is maintained across the electrodes for all plate separations. For each plate separation two readings were taken: one with positive polarity on the high-voltage electrode, the other with negative polarity. The average of the two readings is taken as the measure of the true ionization current. The average of the measured current was used in order to eliminate the effects of parasitic ionization collected along the electrometer connections, and non-ionization electron current. The non-ionization electron current is equal to the difference between the non-ionization electron current collected from the high-voltage electrode and the electron current removed from the collecting electrode.

The ionization currents are correlated with the roentgen as measured with the 25-r Victoreen thimble mentioned earlier.

A plot of the esu/r as a function of plate separation as indicated by the revolutions counter reading is given in Figure 9.

There is no noticeable curvature in the experimental data. The deviation of the experimental points from the straight line determined from the analysis is random for all tests peformed. The assumption that the points determine a straight line appears to be valid. The data obtained with both negative and positive high-voltage polarities are shown. A consistently higher value is obtained for the ionization charge collected per roentgen when the high-voltage electrode is negative with respect to the collecting electrode. The difference between the charge collected with opposite polarities is independent of the electrode spacing. Since considerable care was taken to eliminate the effects of parasitic ionization, the difference must be due to the non-ionization electron current.

The ionization charge collected per roentgen per register reading is determined from a least-squares analysis of the experimental data. The variation of plate spacing based on measurements of the capacity of the parallel plates agreed with the register reading calibration. The analysis is performed by assuming that the data define a straight line and solving for two parameters: the slope and the intercept. The intercept (position of zero electrode spacing) is not assumed prior to analysis because the errors involved in its determination are not consistent with the accuracies obtainable in the rest of the experiment. Combining the results with the revolutions counter calibration and the area of the collecting electrode as measured to the center of the circular groove, the ionization charge density with an upper plate thickness of 0.726 gm./cm.^{2} of polystyrene becomes 0.96 esu/cm.^{3} per roentgen, with a standard deviation of ± 0.01 esu/cm.^{3}-r.

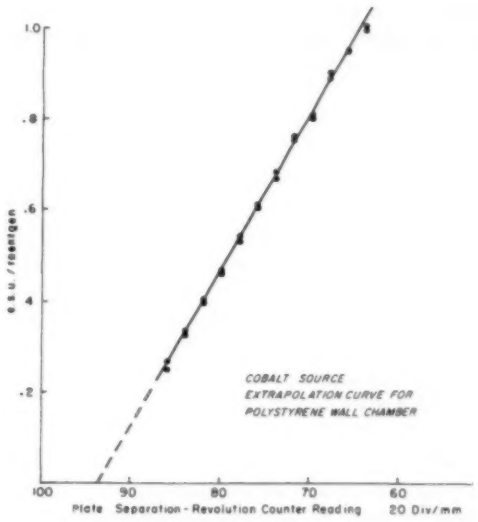

Fig. 9. Plot of the extrapolation chamber ionization charge collected per roentgen as a function of the revolutions counter reading. The plate separation is obtained from the calibration of 20.0 divisions/mm. The roentgen is measured with a Victoreen thimble chamber calibrated at the National Bureau of Standards.

ABSORBED DOSE ON THE BASIS OF CAVITY IONIZATION

The dependence of cavity ionization on the local absorbed radiation dose is related to the manner in which the radiation gives up its energy to electrons. Since all local absorbed dose rates are produced directly or indirectly by energetic electrons, it is important to concentrate on the problem of the actual electron spectrum. The method of calculating the total degraded electron spectrum and its application to absorbed dose and cavity ionization theory has been developed by Fano (1) and Spencer (6, 7). An expression that uses the complete flux spectrum $n_{tot}\ (E)$ of the electrons is:

$$D_w = \frac{1}{\rho_w} \int_{\Delta}^{E_{max}} n_{tot}^{w}\ (E) \left. \frac{dE}{dx} \right|_{<\Delta}^{w} dE \qquad (8)$$

for the absorbed dose in Mev/gm. The letter w refers to the wall material. Then ρ_w is the wall density in gm./cm.^{3}, $n_{tot}^{w}\ (E)$ is the total electron flux in electrons/cm.^{2}-sec-Mev, and $dE/dx\ |_{<\Delta}^{w}$ is the stopping power in Mev/cm. for energy losses less than Δ only. In this form for the dose, the energy limit Δ is arbitrary and may have any value less than or equal to $E_{max}/2$.

When the total electron spectrum is

used to get the ionization in a small cavity in the wall material, the energy limit Δ acquires a natural significance. Then the ionization in esu/cm.^{3} is given by:

$$J_v^a = \frac{1}{\overline{W}_a} \int_{\Delta}^{E_{max}} n_{tot}^w(E) \frac{dE}{dx}\Big|_{<\Delta}^{a} dE \quad (9)$$

where the letter a refers to the gas in the cavity. Then $\overline{W}_a$ is the average energy in Mev dissipated per creation of one esu of charge. The energy limit Δ must be taken as the energy of those electrons whose probable range in the cavity gas is equal to the average dimension of the cavity. This is to be interpreted as saying that the absorbed dose in the cavity gas ultimately comes from electrons that are produced in the cavity itself and whose range is smaller than the dimensions of the cavity. The case in which one or two of the dimensions of the cavity are excessively elongated, as in a parallel plate ionization chamber, may also be handled by calculating an average electron path length for an isotropic electron flux penetrating the cavity. For wall materials with an average atomic number close to the average atomic number of the cavity gas material, the dependence of D/J_v (ratio of absorbed dose to cavity gas ionization density) on cavity dimension will be small.

A calculation for 1.25-Mev gamma rays using Formulae 8 and 9 gives D/J_v = 98.8 erg/gm. per esu/cm.^{3} for a polystyrene wall and air cavity when the parallel plate spacing is about 2 mm. Combined with the experimental value of J_v/r = 0.96 esu/cm.^{3} per roentgen, we have D/r = 94.8 ergs/gm. at a depth of 0.726 gm./cm.^{2} of polystyrene per roentgen in air. For a spacing of 6 mm., the value of D/J_v is 98.6 erg/gm. per esu/cm.^{3}, neglecting leakage or finite beam effects.

ABSORBED DOSE ON THE BASIS OF INCIDENT QUANTITY OF RADIATION

With the gamma ray beam incident on the surface of an absorber, the absorbed dose D at any depth, x, is given by the relation:

$$D(x) = Q\bar{\mu}_e f(x)/\rho \quad (10)$$

where Q is the quantity of radiation in ergs/cm.^{2} at $x = 0$, and ρ is the absorber density. The average value of that portion of the total absorption coefficient which corresponds to kinetic electron energy is $\bar{\mu}_e$ in cm.^{2}/gm. and is obtained by averaging over the gamma-ray spectrum:

$$\bar{\mu}_e = \int \mu_e(E) \cdot Q(E)dE / \int Q(E)dE \quad (11)$$

The factor $f(x)$ combines the effect of attenuation of the incident gamma rays to depth x, and the effect of build-up due to scatter. To evaluate $f(x)$ the asymptotic portion of the central axis depth dose curve is extrapolated to the $x = 0$ point. The asymptotic curve is, in addition, displaced by an amount necessary to adjust for the forward scattering and range of the electrons set in motion by the gamma rays. This new curve represents the energy absorbed from the gamma-ray beam at the point at which the absorption occurs, or at which the electrons are set in motion. An approximate method to obtain the displacement of the asymptotic depth dose curve, when the beam is not too narrow, is to integrate the central axis depth-dose curve from 0 to an extrapolated infinity and then to equate this to the area under the displaced curve which has been extrapolated to $x = 0$ as well (5). The displacement is kept as an unknown parameter to be solved for and gives 0.97 mm. in the present case. The factor $f(x)$ is then the ratio of the value of the displaced curve at $x = 0$ to the value at the depth in question. At the depth of the cavity (0.726 gm./cm.^{2}) $f(x)$ = 0.986.

The value of the average true absorption coefficient for polystyrene for cobalt-60 gamma rays is 0.0300 cm.$^{-1}$ An estimation of the effect of self-absorption by the cobalt source using a calculated spectrum results in an increase of 1 per cent in the coefficient to 0.0303 cm.$^{-1}$. However, this spectrum effect may be found experimentally to be greater, which would require a larger average coefficient. Using the calorimetrically determined quantity

of radiation of 3,370 erg/cm.^{2}-r for the cobalt-60 gamma rays we get $D/r = 96.1$ ergs/gm. at a depth of 0.726 gm./cm.^{2} in polystyrene per roentgen, which corresponds to $D/J_e = 100$ erg/gm. per esu/cm.^{3}, which is again in reasonable agreement with the previous results.

SUMMARY

(1) A calorimetric method of determining the quantity of radiation (ergs/-cm.^{2}) in a beam of radiation with precision is described.

(2) The application of this method to the gamma ray beam from a cobalt-60 source is reported with the result of 3,370 ± 130 ergs/cm.^{2} per roentgen where the roentgen measurement is based on the calibration of a secondary standard at the National Bureau of Standards.

(3) It is shown that theoretically, under these conditions, the roentgen is expected to correspond to a quantity of radiation of 3,250 ergs/cm.^{2} per roentgen.

(4) The design and operation of a precision extrapolation chamber are presented.

(5) The extrapolation chamber was employed to determine that in an air cavity imbedded at a depth of 0.726 gm./cm.^{2} in polystyrene, the ionization density is 0.96 esu/cm.^{3} per roentgen in air.

(6) The utilization of the total degraded electron spectrum in the interpretation of absorbed dose from cavity ionization measurements is illustrated. For an air cavity in polystyrene, the result is 98.8 ergs/gm. per esu/cm.^{3}.

(7) The method of combining the calorimetric determination of quantity of radiation with a depth dose curve to obtain the absorbed dose is illustrated. The result for polystyrene expressed per unit cavity ionization density is 100.1 ergs/gm. per esu/cm.^{3}

CONCLUSION

It is demonstrated that it is technically feasible to determine precisely the quantity of radiation in the gamma-ray beam from a cobalt-60 source. It is further demonstrated that the quantity of radiation combined with a depth-dose curve yields the absorbed dose at any desired depth in an absorber. The absorbed dose so determined in a polystyrene absorber on the basis of a calorimetric measurement agrees closely with the absorbed dose calculated on the basis of cavity ionization. The use of the total degraded electron spectrum was illustrated in this latter calculation.

The utility of this calorimetric method as a primary standard suitable for the calibration of secondary standards is established. Its utility in the determination of absorbed dose is also exhibited. The validity of the Bragg-Gray cavity ionization relation employed with the total degraded electron spectrum is justified by comparison with the calorimetrically determined absorbed dose.

ACKNOWLEDGMENTS: The authors are greatly indebted to M. Danzker for aid on the theoretical analysis of the cavity ionization measurement reported here, and to S. Vacirca and A. Liuzzi for assistance with the extrapolation chamber measurements. The interest and cooperation of Dr. J. J. Nickson, who made the telecobalt source available, is much appreciated.

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(Para el sumario en español, véase la página siguiente.)

SUMARIO

Calibración Absoluta de un Foco de Telecobalto

(1) Descríbese un método calorimétrico para determinar la cantidad de radiación (ergios/cm.^{2}) en un haz de rayos.

(2) Comunícase la aplicación de este método al haz de rayos gamma procedente de un foco de cobalto-60, dando por resultado 3370 ± 130 ergios/cm.^{2} por roentgen, basando la medición del roentgen en la calibración de un patrón secundario en la Oficina Nacional de Normas y Tipos de los E.U.A.

(3) Demuéstrase que teóricamente se espera que el roentgen corresponda a una cantidad de radiación de 3250 ergios/cm.^{2} por roentgen.

(4) Expónense el diseño y el funcionamiento de una cámara de extrapolación de precisión.

(5) Se empleó la cámara de extrapolación para determinar que en una cavidad aérea incrustada a una profundidad de 0.726 gramos/cm.^{2} en polistireno, la densidad de la yonización es de 0.96 esu/cm.^{3} por roentgen al aire.

(6) Ilústrase la utilización del espectro total de electrones degradados en la interpretación de la dosis absorbida de las mediciones de la yonización en la cavidad. Para una cavidad de aire en polistireno, el resultado es 98.8 ergios/gramo por esu/cm.^{3}

(7) Ilústrase el método usado de combinar la determinación calorimétrica de la cantidad de radiación con una curva de la dosis profunda para obtener la dosis absorbida. El resultado para el polistireno expresado en densidad de yonización en unidad cavitaria es 100.1 ergios/gramo por esu/cm.^{3}.

Queda demostrado que, técnicamente, es factible determinar con precisión la cantidad de radiación en el haz de rayos gamma procedente de un foco de cobalto-60. Queda además demostrado que la cantidad de radiación combinada con una curva de dosis profunda da la dosis absorbida a cualquiera profundidad deseada en un absorbente. Determinada en esa forma en un absorbente de polistireno a base de una medición calorimétrica, la dosis absorbida convino aproximadamente con la dosis absorbida calculada a base de la yonización de la cavidad. El uso del espectro total de electrones degradados fué ejemplificado en este últimc cálculo. La validez de los componentes del espectro y de la facultad contenedora en este cálculo fué comprobada independientemente por medio de la medición de la yonización en gas acetileno en una cavidad en polistireno.

Queda establecida la utilidad de este método calorimétrico como patrón primario apropiado para la calibración de patrones secundarios. Queda también puesta de manifiesto su utilidad en la determinación de la dosis absorbida. La validez de la relación de Bragg-Gray de la yonización en cavidad empleada con el espectro total de electrones degradados queda justificada por la comparación con la dosis absorbida determinada calorimétricamente.

DISCUSSION

G. Failla, D.Sc. (New York): We have had the pleasure of listening this morning to reports on two excellent pieces of work.[1] The measurement of energy absorbed by means of a calorimeter is a very difficult problem in view of the very small amount of heat involved. The accomplishments that were presented to us this morning are really very substantial and I wish to congratulate the speakers.

From the point of view of the radiological physicist, we have to appraise the situation in more general terms. Since these measurements are very difficult and the error at the present time is considerable, the question arises as to whether one should go on and exploit this means of measuring absorbed doses to the limit and improve the methods, etc. In other words, should the young physicist getting into this field spend

[1] The other: Calorimetric Method of Measuring Energy Locally Absorbed, by Johns and Bernier, to be published.

a lot of time improving these methods. My personal feeling is that what these calorimetric measurements do is to check the theories of absorption of x-rays by matter. All the results that were presented here can be derived from ionization measurements. In fact, Dr. Laughlin and his group have made such ionization measurements and calculations and have compared the results with those obtained by the calorimeter method.

The question arises in my mind as to whether it isn't preferable to check the laws of absorption of x-ray by the calorimeter method under conditions in which one is not dealing with such small amounts of energy. By choosing the most advantageous conditions, greater accuracy can be achieved. If close agreement between the two methods is established for widely different x-ray energies, accurate dosimetry can be carried out without the use of a calorimeter. If, on the other hand, there are differences, then we will have a better way of determining the constants that are used at the present time for the determination of energy absorbed by the ionization method. I emphasize this simply because it would be rather unfortunate if every radiological physicist set up a calorimeter in the x-ray department in order to be "up-to-date" and measure energy absorbed in a more direct way than is done by the usual ionization chamber method. In other words, I consider the calorimetric approach a distinct advance in dosimetry which will eventually enable us to use the ionization method with greater accuracy and assurance, rather than supplant it. Therefore, calorimetric work should be carried out only under the best conditions in a few laboratories.

Laminagraphy in Acute Maxillofacial Injuries[1]

RICHARD F. McCLURE, M.D.

THE RADIOGRAPHIC examination of the maxilla and mandible for evidence of fracture is a tedious procedure. The examination is especially difficult when the patient has suffered additional severe injuries elsewhere in the body. The presence of splints and bulky dressings interferes with the precise positioning of the head which is required for accurate maxillofacial radiography. A complete and satisfactory examination is often unobtainable under these circumstances. Too often, in such cases, the oral surgeon must either base his treatment upon inadequate films or delay treatment until the clinical condition of the patient permits a satisfactory x-ray examination. This report describes a laminagraphic method of examining the mandible and facial bones which can easily be performed under circumstances which would interfere with or prevent examination by the routine radiographic procedures. A review of recent literature has not disclosed any account of the laminagraph being put to this use.

At the U. S. Naval Hospital, Camp Pendleton, Calif., many patients were seen immediately following high-speed automobile collisions. In most cases there was clinical evidence to suggest severe mandibular and facial bone trauma. Injuries of the spine and of the extremities were common complications. Radiography of the facial bones upon admission to the hospital was unsatisfactory in most cases. Our discontent with the diagnostic value of the examinations and the delay in treatment by the oral surgeon because of the deficiencies of the films prompted us to search for some method which would give adequate information about the mandible and facial bones in a severely injured patient as soon as he could be brought to the x-ray department from the receiving ward.

Using the laminagraphic technic to be described here, we were able to obtain a complete and satisfactory examination of the mandible and facial bones of 28 severely injured patients within twenty-four hours after admission to the hospital. Two of the patients were completely unconscious at the time of laminagraphy, yet satisfactory films were obtained.

The technic is a simple one. When a patient in whom facial bone fractures are suspected arrives in the x-ray department, he is placed on the examining table in either the prone or supine position. Satisfactory films can be obtained in either position, but the bony detail is slightly better with the patient prone. The sagittal plane of the skull must be perpendicular and the coronal plane parallel to the table top. These are the only two requirements for proper positioning. The head is then immobilized. The central ray is directed through the plane of the malar processes of the maxillary bones. The initial film is focused at the level of the nasal spine, with subsequent films focused at 1-cm. intervals posterior to this. A total of five films taken in such a manner will demonstrate the facial bones adequately.

A fracture of the mandible is almost as easy to demonstrate as one of the maxilla. Fractures of the subcondylar portion of the ramus of the mandible are easily shown in the sagittal projection by positioning the head as described for the facial bones and focusing the film at the level of the temporomandibular joint as palpated through the skin. It is best, however, to place the patient in the prone position, turning the head so that the affected side of the mandible is brought into a position approximately parallel to the table top. Only two films are required for one side: the initial film is focused at a point 1 cm. above

[1] Presented as a scientific exhibit at the Thirty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 13–18, 1953. Accepted for publication in August 1954.

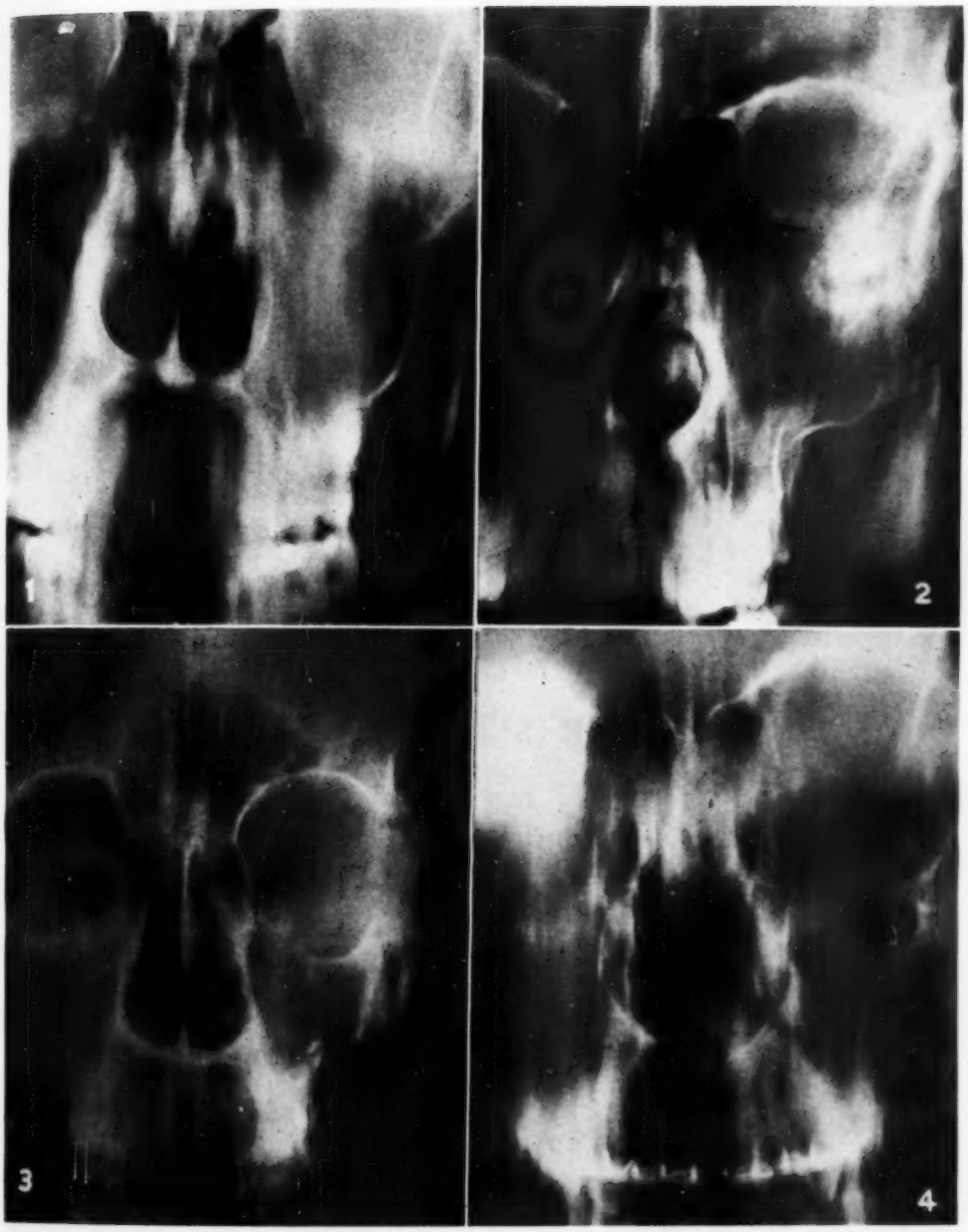

Fig. 1. Postero-anterior laminagraph focused at 5 cm., showing a fracture of the lateral wall of the left maxillary antrum.

Fig. 2. Postero-anterior laminagraph focused at 6 cm., showing a comminuted fracture of the lateral wall of the left antrum. The comminution was not visible on the plain films.

Fig. 3. Postero-anterior laminagraph focused at 4.5 cm., showing fractures of the zygomaticofrontal suture and inferior orbital rim and comminution of the lateral wall of the maxillary antrum.

Fig. 4. Postero-anterior laminagraph focused at 3 cm., showing bilateral fractures of the medial walls of both maxillary antra. This is a post-reduction film.

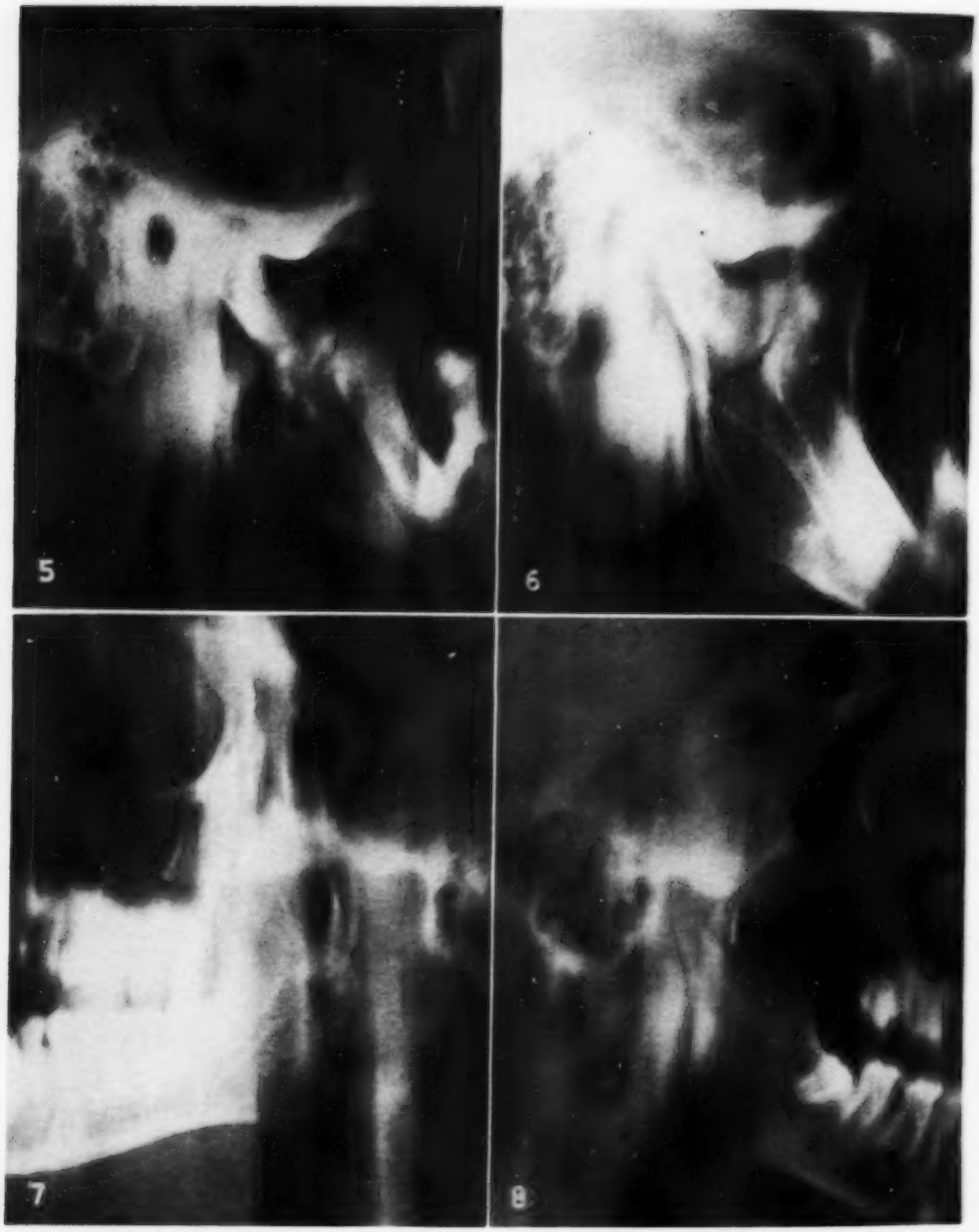

Fig. 5. Lateral laminagraph focused at 1 cm., showing a fracture of the mandibular condyle with overriding of the fracture fragments. No dislocation.

Fig. 6. Lateral laminagraph focused at 1 cm., showing a linear fracture of the base of the mandibular condyle. No displacement. No dislocation. This fracture was invisible on the plain films.

Fig. 7. Lateral laminagraph focused at 2 cm., showing a fracture of the right mandibular condyle with anterior dislocation and overriding of the fragments.

Fig. 8. Same case as Fig. 7. Lateral laminagraph focused at 3 cm., showing a fracture of the left mandibular condyle with anterior dislocation and overriding of fragments.

the table top, and the second film at a point 1.5 above the table top. These points of focus apply when the skin surface of the side of the face can be brought into contact with the table. If dressings interfere, adjustments in focal level must be made. The exposure factors we have used are as follows: (*a*) par-speed screens; (*b*) 40 inches target-film distance; (*c*) 150 milliampere-seconds; (*d*) amplitude of tube travel, 15 inches; (*e*) 8:1 Bucky grid ratio; (*f*) kvp equivalent to 2.5 × part thickness in centimeters plus 22.

The use of the laminagraphic technic always raises the question of unnecessary over-irradiation of the patient. We have measured the total radiation at a point 1 cm. above the table top with routine radiographic examination of the facial bones (six exposures) and have made similar measurements for the laminagraphic method of examination when the usual 5 exposures are made. In the first instance, the total radiation is 11.5 r. With the laminagraphic method, the total is 16.3 r. This slight difference is of little significance in view of the other advantages of laminagraphy.

Laminagraphy as the initial radiographic procedure in injuries of the face and jaw has definite advantages: (*a*) Positioning of the head is simple. In most cases a single position will suffice. (*b*) We have not found it necessary to repeat the laminagraphic films because of unsatisfactory position of the part. A repetition of the examination is often required when routine methods are used in severely injured patients. (*c*) Laminagraphs often give more information than routine films. We have been surprised on several occasions to find fractures clearly visualized on the laminagraph that were otherwise difficult to see or even completely missed. (*d*) The ease and accuracy of laminagraphy saves time for the patient and the x-ray department.

It must be admitted that there is one weak point in the laminagraphic examination of the facial bones. This is the demonstration of the malar arch. Due to its anatomical position, the malar bone cannot be shown as clearly as the other bones of the face. Yet, when profile views of the malar arches are impossible to obtain or are contraindicated, the malar bones can still be seen well enough on the laminagraphs to make possible a reasonable diagnosis.

SUMMARY

Using a laminagraphic apparatus, we have been able to examine for fracture the mandible and the facial bones in patients whose clinical condition made standard methods of radiographing these parts either impossible or, at best, extremely difficult. The method is highly efficient from the standpoint of diagnostic information. It is actually time-saving and easier to use than routine methods.

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SUMARIO

La Laminagrafía en las Lesiones Maxilofaciales Agudas

La técnica laminagráfica ha sido aplicada, con excelente resultado, al examen de los enfermos que tienen lesiones maxilofaciales agudas. Para la observación de los huesos faciales, se coloca al enfermo sobre la tabla de rayos en posición prona o supina, con el plano sagital del cráneo perpendicular y el plano coronal paralelo a la superficie de la mesa. El rayo central se asesta a través de las apófisis malares del hueso maxilar superior. La radiografía inicial se enfoca al nivel de la espina nasal y las radiografías subsiguientes se toman a espacios de 1.0 cm. después. Basta con cinco radiografías.

Se observan en forma semejante las fracturas del maxilar inferior, en vistas sagitales.

Osteochondrosis in the Cervical Spine[1]

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PATIENTS with cervical neuralgia usually have x-ray examinations of the cervical spine. If the radiographs show degenerative lesions, there is reason to believe that most doctors accept these as the explanation for the complaints.

I will not here take any point of view regarding the many theories which attempt to explain the cervicobrachial syndrome. Preliminary mention should be made, however, of the fact that roentgenologic degenerative changes in the cervical spine have so often been observed in persons presenting no clinical symptoms that the x-ray investigation, according to many authors, is of no importance in cases of common brachial neuralgia. That the roentgenogram is nevertheless important in order to exclude more serious disorders, it is of course unnecessary to point out.

In this paper, which does not claim to keep to strict scientific standards, but which, it is hoped, will permit some positive conclusions, I have tried to answer three simple questions:

1. How often is it possible to demonstrate pathological x-ray findings in persons without clinical symptoms, and how often in persons who have or have had brachial neuralgia?
2. How often has cervical neuralgia been present in persons with pathological x-ray findings in the cervical spine?
3. What is the distribution of the pathological x-ray findings in the cervical spine?

The present material consists of a larger group of 320 persons and a smaller one of 77. The larger group (182 men and 138 women), between forty and eighty-nine years of age, was chosen from among the patients of an x-ray department having widely different diseases without any relation to the cervical spine. They were all examined radiographically in the erect lateral position and also in a right and left 45-degree oblique position, at a distance of 1.2 meters from the tube. The radiographs were obtained after screening the patient, turning him one way or the other until the intervertebral foramina were seen most clearly.

The smaller group consisted of 77 healthy soldiers between eighteen and thirty years of age. None of them had ever had any symptoms of brachial neuralgia. Only lateral radiographs were taken in these cases, for the purpose of investigating the usual dimensions of the disk spaces at different levels in presumably normal subjects in whom we must assume that roentgenologically visible degenerative findings had not yet developed. Here there is no general agreement. Most authors consider that the disks become increasingly thick from above downward, while others believe that they are of uniform thickness. If a disk is thinner than the one above, it is assumed to be degenerated. Others, however, consider that a single disk, especially that between C-6 and C-7, may normally be thinner than the one above.

In the group of 77 healthy men there were 11 with one disk a little thinner than the one above. Eight of this number were between eighteen and twenty years of age. From this, it appears permissible to conclude that a single thin disk without other pathological x-ray findings can be normal and consequently can be considered normal also in the higher age groups. This opinion can probably neither be disproved nor confirmed. There has not been published, so far as the author knows, any account of dissections in young subjects in whom the cervical spine has been investigated after having been studied radiographically just before the dissection.

In the group of 320 persons investigated, a thin disk without any other radiological

[1] Accepted for publication in August 1954.

abnormality was classed as a normal variation. This was observed in 18 subjects. In accordance with the x-ray findings this larger group was divided into 4 different types:

1. Normal, including a thin disk but no other apparent abnormality.

2. One thin disk plus (*a*) narrowing of the related foramina with or without osteophytes on the anterior brim of the vertebral bodies, or (*b*) osteophytes on the anterior brim with or without narrowing of the foramina; osteophytes on the anterior brim; narrowing of the foramina.

3. Two thin disks with or without narrowing of the related foramina or osteophytes of the anterior brim.

4. Three or more thin disks plus narrowing of the foramina and osteophytes on the anterior brim of the corpora.

All the subjects concerned were questioned regarding past or present brachial neuralgia. Further consideration is given in Tables I and II to those who had experienced the following symptoms: pain and stiffness in the neck, pain in the back of the head, radiating pain to the shoulder and arm with or without paresthesia in the fingers.

TABLE I: CLASSIFICATION OF 320 PATIENTS IN ACCORDANCE WITH ROENTGEN FINDINGS AND AGE

Roentgen Group with no. of patients	Age 40–59	Age 60–89	Average Age
1 (83)	72	11	48.6
2 (44)	24	20	58.3
3 (84)	36	48	61.8
4 (109)	29	80	65.5
TOTAL (320)	161	159	

In Table I, correlating age and roentgen observations it is seen that positive findings increase with advancing years and, furthermore, that normal findings are infrequent after the age of sixty.

Table II shows that abnormal x-ray appearances are equally common in patients with and without clinical symptoms. In the asymptomatic group (182 persons), the abnormalities numbered 133 (73 per cent) whereas 104 of the 138 persons with symptoms showed positive findings (75 per cent). Of 237 persons with radiographic abnormalities, 104 (44.3 per cent) had clinical symptoms, while 133 (55.7 per cent) did not. The largest group with positive x-ray findings, therefore, was made up of subjects without symptoms.

TABLE II: CLASSIFICATION OF 320 PATIENTS IN ACCORDANCE WITH ROENTGEN FINDINGS, AGE, AND CLINICAL SYMPTOMS

Roentgen Group	Clinical Symptoms	Age 40–59	Age 60–89	Total	
1	+	30	4	34	
	−	42	7	49	
2	+	10	8	18	
	−	14	12	26	
3	+	15	22	37	104+
	−	21	25	46	133−
4	+	13	36	49	
	−	16	45	61	
TOTAL	+			138	
	−			182	

Table III shows the distribution of the single x-ray findings which have already been described. Reduction of the disk space is the most common change. Narrowing of the foramina is seldom seen alone (in only 2 of 237 subjects). Osteophytes on the anterior vertebral margins are rarely found alone, being usually associated with reduction of the disk space and with or without narrowing of the foramina. An investigation of the distribution of the individual x-ray findings in the two groups, with and without clinical symptoms, revealed no preponderance of any single finding in either group. The disk between C-6 and C-7 was found to be the thinnest in 126 cases, that between C-5 and C-6 in 115, between C-4 and C-5 in 28, and between C-3 and C-4 in 5 cases. The largest osteophytes were

TABLE III: DISTRIBUTION OF INDIVIDUAL ROENTGEN FINDINGS

	No. Cases
Thin disk plus narrowing plus osteophyte	192
Thin disk plus narrowing	15
Thin disk plus osteophyte	24
Narrowing	2
Osteophyte	3
Narrowing plus osteophyte	1
TOTAL	237

located near the disk between C-6 and C-7 in 169 cases, C-5 and C-6 in 154, C-4 and C-5 in 37, and C-3 and C-4 in 5 cases. The pathologic x-ray changes are most pronounced therefore in the disk between C-6 and C-7.

DISCUSSION AND CONCLUSIONS

The value of investigations of this kind is limited because there are so many errors in judgment in regard to the material itself. The grouping, for example, was based upon the remembrance of earlier neck pain. We know well what different importance various patients ascribe to their pains. There is also reason to believe that some of the neck pains which here appears as cervical pain actually have nothing to do with possible degenerations in the cervical spine. With these reservations, the investigation shows that degenerative lesions of the cervical spine which are demonstrable radiologically occur as often in persons with as without symptoms, 73 and 75 per cent, respectively. The radiological abnormalities increase with age and are nearly always present in persons over sixty years old. The x-ray findings are equally distributed in both clinical groups. The most common lesion is destruction of the disks with narrowing of the foramina.

An investigation of healthy men in the age group eighteen to thirty years showed in 11 out of 77 cases a disk which was thinner than the one above. Possibly such a finding at this early age is an anomaly without any pathological importance. It is difficult to believe that degenerative changes should be demonstrable radiologically in apparently healthy young adults below the age of twenty.

With care, especially with fluoroscopic control of the position, it is possible to obtain an accurate impression of the intervertebral foramina and to deduce the nature and degree of pathologic changes in the cervical spine. Remembering, however, that a given pathological picture may be present with or without symptoms, we must be very guarded in radiological interpretation in the present state of our knowledge.

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SUMARIO

Osteocondrosis en la Porción Cervical del Raquis

Dos grupos fueron examinados en busca de signos de alteraciones en la porción cervical del raquis: (1) 77 varones sanos de dieciocho a treinta años de edad; (2) 320 personas entre cuarenta y ochenta y nueve años de edad observadas en el departamento de roentgenología con respecto a enfermedades sumamente diversas que no guardaban relación con la porción cervical de la espina dorsal. Las últimas fueron interrogadas acerca de la presencia de neuralgia braquial y de ciertos síntomas pertinentes.

Descubrióse que existen lesiones degenerativas de la porción cervical del raquis, que son observables radiológicamente, con igual frecuencia en personas con o sin síntomas, 73 y 75 por ciento, respectivamente. Las anomalías radiológicas aumentan con la edad y se hallan casi siempre

presentes en personas de más de sesenta años. La lesión más común es la destrucción de los discos con estrechamiento de los agujeros.

La investigación de varones sanos del grupo de dieciocho a treinta años de edad reveló en 11 de los 77 casos un disco más delgado que el que le quedaba más arriba. Posiblemente un hallazgo de ese género a una edad tan temprana representa una anomalía sin importancia patológica.

Desplegando cuidado, y sobre todo con la regulación fluoroscópica de la posición, es posible obtener una impresión exacta de los agujeros intervertebrales y deducir la naturaleza y magnitud de las alteraciones patológicas en la porción cervical del raquis. Sin embargo, al recordar que puede existir un cuadro patológico dado con o sin síntomas, hay que mostrar mucha reserva en la interpretación radiológica en el estado actual de nuestros conocimientos.

Bone Density Measurements of Osteoporosis in the Aged[1]

J. GERSHON-COHEN, M.D., HARALD SCHRAER, Ph.D., and NATHAN BLUMBERG, M.D.[2]

OSTEOPOROSIS as diagnosed by the roentgenologist lacks the objectivity necessary for accuracy (1). Many physical aids have been suggested (2–6), but those of the Pennsylvania State University physicists (7–9), by which quantitative estimates of bone density may be obtained with the use of densitometric and computation equipment, seemed to us to be the most advanced. With their collaboration, the roentgenographic evaluation of osteoporosis was undertaken in a group of aged persons, and the preliminary findings are here reported. The densitometer used has been specially modified for this purpose. The computors consist of a function transformer and recording, integrating, and counting devices.

Fig. 1. Tracing paths for density evaluation of the middle phalanx of the fifth finger and of the os calcis are indicated by etched lines.

METHODS

Skeletal x-ray examinations were made of 149 healthy ambulatory residents in the Home for the Jewish Aged in Philadelphia. This group comprised 52 men and 97 women ranging from sixty-three to ninety-eight years of age. The densitometric analyses were made from non-screen x-ray films of the left hand and foot of each subject. An aluminum-zinc alloy wedge was simultaneously exposed after being placed on the film, with a constant film-target distance of 40 inches (Fig. 1). For measuring the thickness of the soft tissues over the os calcis, a narrow strip of lead 1/16 inch thick was wrapped around the posterior aspect of the heel. The bone density coefficients were then calculated by the physicist group and later compared with our roentgenographic clinical appraisal of osteoporosis.

The figures supplied by the physicists were reported as an average "density coefficient" for the particular cross-sectional slice of bone evaluated, indicated by

[1] From the Albert Einstein Medical Center, Northern Division, and the Home for the Jewish Aged, Philadelphia, Penna. Accepted for publication in September 1954.

This investigation was supported by a grant, A-602(R), from the U.S. Public Health Service, National Institutes of Health.

[2] Professor of Clinical Medicine and Geriatrics, Hahnemann Medical College.

the etched lines in Figure 1. This density coefficient can be multiplied by a constant factor defining the density of the bone in grams of bone ash per cubic centimeter of bone. This conversion factor is approximately 0.32, but its exact value must await additional experimental work. In the meantime our results are reported merely in terms of "density coefficient." In the case of soft tissues, this coefficient is simply a measure of the relative x-ray absorbing power of the tissues and has no known relationship to their density.

RESULTS

Study of the frequency distribution of density coefficients indicated that the women of this group had bones of lesser density than the men. Most of the women showed a density coefficient between 0.55 and 0.59 for the os calcis, while that of the men fell between 0.60 and 0.64. Worthy of note perhaps is the narrow peak for the women and the broader peak for the men (Fig. 2).

Frequency distribution curves of density coefficients obtained through the middle phalanx of the left fifth finger showed more variation among the women than among the men, when measured through the midshaft; but when measurements were made through the metaphyses, the coefficient curves resembled those of the os calcis (Figs. 3 and 4). The density coefficient of the middle phalanx of the fifth finger was greater for both sexes than for the os calcis.

Evaluation of the degree of osteoporosis of the middle phalanx of the fifth finger and of the os calcis by the roentgenologist was compared with the findings of the physicists in the following manner: The degree of osteoporosis was graded roentgenologically as minimal (Grade I), moderate (Grade II), and advanced (Grade III). These estimates were then compared in each case with the corresponding density coefficients. A surprisingly good correlation was obtained.

Likewise, evaluation of the degree of osteoporosis on the basis of lateral x-ray

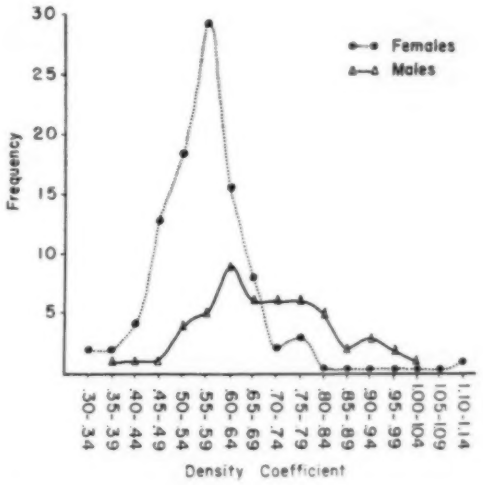

Fig. 2. Range of bone density coefficients for the os calcis.

views of the dorsolumbar spine was compared with the density coefficients obtained either through the os calcis or middle phalanx of the fifth finger. Here no relationship seemed to exist. The physicists at present are attempting to devise methods translating bone density values of the dorsolumbar spine into density coefficients, after which comparisons will again be attempted.

Probably more important than the frequency distribution curves are the bone density values determined for each individual. A glance at Figures 3 and 4 immediately indicates the wide individual variations. But since these physical measurements are accurately reproducible (10, 11), it should be possible to evaluate the influence of such factors as age, nutrition, hormone and mineral balance on the evolution of osteoporosis (12–15).

DISCUSSION

Study of the curves of bone density coefficients by decades did not reveal decreasing, but rather slightly increasing levels of bone density with advancing age. Since the number of individuals in this study was small, these statistical impressions may not be wholly valid. The findings are to be rechecked later and compared if

possible with readings of other groups in other institutions. The observations made also suggest the advisability of looking for osteoporosis earlier in life, before as well as after the climacterium for both men and women. The finding of minimal osteoporosis in the ninth and tenth decades of senile osteoporosis. Encouraging is the fact that these x-ray density measurements are reproducible to within 5 per cent, thus eliminating one of the previously important uncontrolled variables. The soft-tissue mass surrounding the bone must be determined by special computation to

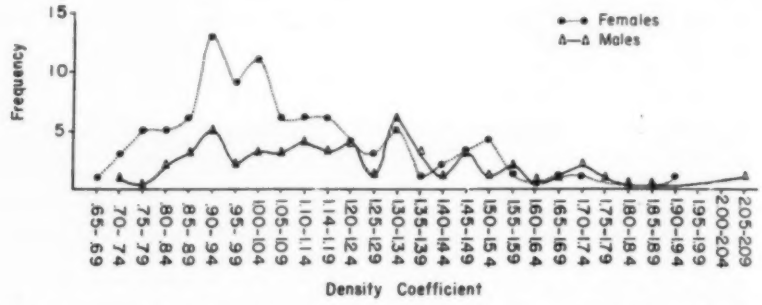

Fig. 3. Range of bone density coefficients for the midshaft of the middle phalanx of the left fifth finger.

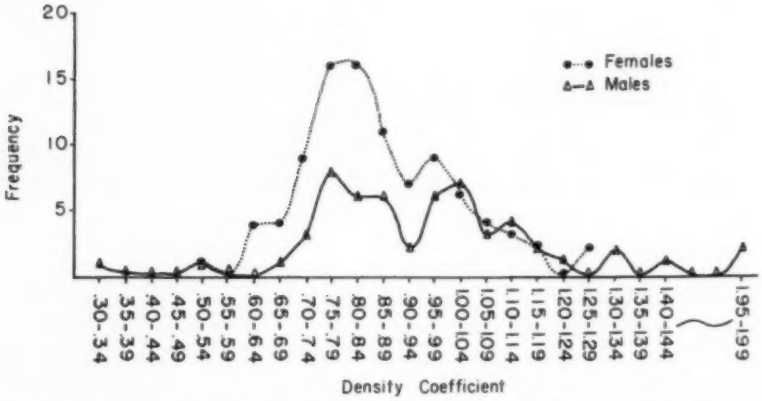

Fig. 4. Range of averaged bone density coefficients for the metaphyses of the middle phalanx of the left fifth finger.

might be one of the reasons for longevity; or the explanation may lie in the good dietary of the domiciliary institution for this small group of individuals. These factors are being studied currently.

While bone density measurements have been done on hundreds of normal persons (10), this study is the first attempted by us for the systematic study of a group of aged subjects who will be available for periodic re-examination. It is hoped that such studies will lead to a better appraisal give a correct figure for bone density. It is hoped that similar technics can be evolved later for the spine, where the clinical radiologist more frequently finds evidence of osteoporosis in the aged, especially when complicated by arthritis.

SUMMARY

Of 149 residents of the Home for the Jewish Aged in Philadelphia, including 52 men and 97 women ranging from sixty-three to ninety-eight years of age, density

coefficients of bone mineralization were obtained with the aid of physicists at Pennsylvania State University. These objective measurements were obtained with a modified densitometer and computation equipment consisting of a function transformer and recording, integrating, and counting devices. Frequency distribution of these density coefficients was determined by sex and for the whole group. Individual determinations were compared with clinical x-ray estimates of osteoporosis. While there was good correlation in the studies of the os calcis and the middle phalanx of the fifth finger, the correlation was poor when the same physical measurements were compared with the degree of clinical osteoporosis of the spine. These records of individual density coefficients in the aged are highly reproducible and make possible a better appraisal of the degree of osteoporosis in relationship to such factors as time, nutrition, and mineral and hormone balance.

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SUMARIO

Mediciones de la Densidad Osea en la Osteoporosis de los Ancianos

Por medio de un densitómetro y de instrumental computador obtuviéronse coeficientes de densidad de la mineralización ósea en las radiografías de 52 hombres y 97 mujeres cuya edad variaba de 63 a 98 años. Las mediciones se hicieron en la falange media del dedo meñique izquierdo y sobre el calcáneo. Se determinaron las distribuciones de la frecuencia de los coeficientes de densidad para cada sexo así como para el grupo en conjunto. Las mujeres resultaron tener huesos de densidad algo menor que la de los hombres. El grado de la osteoporosis fué mínimo en el noveno y el décimo decenios de vida.

Se compararon las determinaciones individuales de la densidad con los cálculos roentgeno-clínicos de la osteoporosis en los mismos enfermos. Aunque hubo buena correlación en los estudios del calcáneo y de la falange media del dedo meñique, la correlación fué mala cuando se comparaban las mismas mediciones físicas con el grado de la osteoporosis clínica en el raquis.

Estos datos de coeficientes individuales de densidad en los ancianos son sumamente reproducibles y permiten hacer una apreciación mejor de los grados de osteoporosis en relación con factores tales como tiempo, nutrición y equilibrio mineral y hormónico.

An Improved X-Ray Stand[1]

I. KLEIN, M.D.

DURING MANY years of experience with various types of portable x-ray stands we have found these, in general, to be too heavy and cumbersome for our purposes. These disadvantages of weight and performance led us to design a new stand, which has proved satisfactory for use in hospital, office, and home. It is especially adapted to home use.

The portable x-ray stand is made primarily of aluminum tubing, which is welded into a "V"-shaped mobile base. The base has a double-section upright at the point of impingement of the two base tubes. These sections, in the upright, can easily be assembled or taken apart. The projection arm is attached to the upright with a screw knob and can thus be fixed at different levels. A shock-proof head fastens to the projection arm. Figure 1 shows the stand assembled.

When the head is fastened to the projection arm, it can be rotated 360 degrees, plus 225 degrees in its yoke. The projection arm itself has a vertical play of 15 inches on the upper section of the upright, controlled by a locking device. This mobility of the head and arm of the unit permits the taking of roentgenograms readily in both the upright and the prone position (Fig. 2).

The portable stand is both flexible and light. It weighs only 23 pounds. It is easy to handle, as the equipment can be carried on the base of the stand. Figure 3 shows the stand with the equipment ready to be carried. The stand can be used as well for transporting the carrying case.

Fig. 1. X-ray stand assembled.

We have used this portable x-ray stand for over five years. It is a light, sturdy, and mobile unit. It is easy to assemble and dismount, and it can be adapted readily to both upright and prone positions. It is an aid in the attainment of good portable roentgenograms.

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[1] Accepted for publication in September 1954.

SUMARIO

Mesita Perfeccionada para Radiografía

Descríbese una mesita portátil para radiografía, que está construída de tubos de aluminio y tiene un brazo proyector movible. Es de peso liviano y de construcción sólida. Es fácil montarla y desmontarla y puede acomodarse sin dificultad para la roentgenografía, con el enfermo en decúbito prono o erguido.

Fig. 2. Use of the x-ray stand for roentgenography in upright and prone positions.

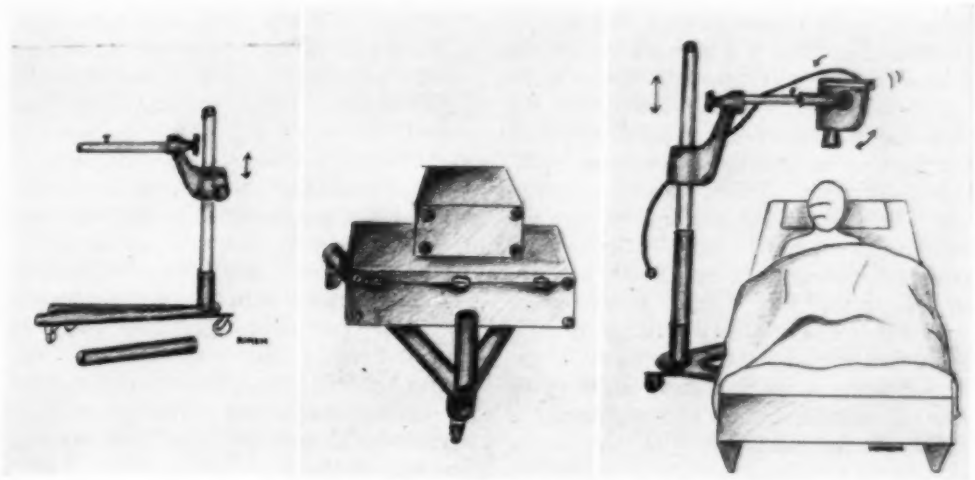

Fig. 3. Stand disassembled for carrying.

Clinical and Roentgenologic Evaluation of Routine 2-Gram Telepaque Dosage in Cholecystography[1]

WALTER M. WHITEHOUSE, M.D.,[2] and O. MARTIN, M.D.[3]

EARLY CLINICAL evaluation and comparison with Priodax demonstrated the much denser gallbladder shadows found after ingestion of Telepaque in 3-gm. dosage and also showed a high incidence of unabsorbed contrast material in the colon. These findings pointed to the possibility that the 3-gm. dosage might be excessive, and it was suggested by others and concurred in by us that a thorough trial of a smaller dosage was indicated (1-6). Accordingly, a routine 2-gm. dosage was instituted at the University Hospital. Following the trial period for accumulation of data, this proved so satisfactory that it has been continued as standard cholecystographic procedure.

A previous study at this institution (6) evaluated the side-effects of the 3-gm. dose of Telepaque in comparison with an equal dose of Priodax. Under identical conditions, cholecystographic subjects were interviewed by a physician as they passed through the gastrointestinal suite, and the side-effects of the 2-gm. dosage were tabulated. The contrast material was ingested exactly as in the previous study, *i.e.*, following a fat-free meal the evening prior to examination. The incidence of side-effects as compared with the earlier Priodax and Telepaque (3-gm.) series is presented in Table I.

TABLE I: INCIDENCE OF SIDE-EFFECTS OF PRIODAX AND TELEPAQUE IN 3-GM. AND 2-GM. DOSES

	Priodax: 3 gm. (per cent of 500 cases)	Telepaque: 3 gm. (per cent of 400 cases)	Telepaque: 2 gm. (per cent of 500 cases)
Nausea			
Mild	15.2	5.8	6.6 (33 cases)
Severe	1.4	0.0	0.4 (2 cases)
Vomiting			
Mild	1.0	0.5	2.2 (11 cases)
Severe	0.4	0.0	0.2 (1 case)
Diarrhea			
Mild	27.0	22.8	17.6 (88 cases)
Severe	6.4	2.5	0.4 (2 cases)
Dysuria			
Mild	24.4	13.7	9.0 (45 cases)
Severe	0.4	0.0	0.2 (1 case)
Other			
Mild	4.6	2.8	4.2 (21 cases)
Severe	0.2	0.0	0.4 (2 cases)
None	41.4	62.5	66.2 (331 cases)

The comparative figures show a small increase over the 3-gm. Telepaque group in absence of side-effects and a slight decrease in the two more frequent effects, mild diarrhea and mild dysuria, the reductions in these symptoms being in the neighborhood of 4 to 5 per cent. Thus it appears that the smaller 2-gm. dose enjoys an advantage in this respect when used as a routine procedure.

The other chief concern in use of the reduced dosage is its effect on the density of the gallbladder shadow. A review of 500 examinations was carried out with the same standards employed in our previous studies (6), and gallbladder visualization was classified under the same headings: excellent, good, faint, or non-visualization, for each examination. The presence of stones was also recorded and it was noted whether they were radiolucent, radiopaque, or mixed. The incidence of residual contrast material in the colon was tabulated.

Gallbladder visualization with 2-gm. dosage is compared with the previous study of 3-gm. dosage in Table II.

While there appears to be a 13 per cent decrease in the "excellent" category, an increase of 9.2 per cent is noted in the "good" results. If the excellent and good classifications are combined and considered

[1] From the Department of Radiology, University Hospital, Ann Arbor, Mich. A portion of this material was presented as an Exhibit at the Thirty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 13–18, 1953. Accepted for publication in September 1954.

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as "satisfactory" the 3-gm. dosage shows an advantage of 3.8 per cent over the 2-gm. dosage, 83 as compared to 79.2 per cent. This small decrease in diagnostic shadows with the lower dosage may be counterbalanced by the risk of obscuring stones by the dense shadows produced by 3 gm.

TABLE II: GALLBLADDER VISUALIZATION WITH TELEPAQUE; 3 GM. AND 2 GM.

Gallbladder Visualization	3-gm. (per cent)	2-gm. (per cent)
Excellent	59.6	46.6
Good	23.4	32.6
Faint	7.6	10.2
Non-visualization	10.6	9.4

Of the 500 patients receiving 2 gm., 487, or 97.4 per cent, showed residual contrast medium in the colon. This rarely confused the interpretation of the cholecystogram and has the advantage, as emphasized previously, of serving as positive evidence that the patient has ingested the contrast medium. This is especially important in cases of non-visualization of the gallbladder, when one must be doubly sure that the patient has ingested the material and that it has progressed in the gastrointestinal tract.

In a large institution, where many cholecystograms are taken, it is advantageous to have a routine procedure which does not necessitate the adjustment of dosage of the contrast material to the weight of the patient. To see if the 2-gm. dosage satisfied this requirement, 100 patients were selected at random, 50 weighing 170 lb. and over and 50 weighing 130 lb. and under. The density of the gallbladder shadow in these cases was as shown in Table III.

A greater proportion of the thin individuals showed the extremely dense "excellent" gallbladder shadow. A compensatory greater number of "good" shadows, however, are observed in the group weighing 170 lb. and over. If the "good" and "excellent" groups are combined as "satisfactory," it is apparent that in both weight groups satisfactory densities are obtained

TABLE III: GALLBLADDER VISUALIZATION WITH 2 GM. TELEPAQUE ACCORDING TO BODY WEIGHT

Visualization	170 lb. and over	130 lb. and under
Excellent	15	25
Good	25	16
Faint	7	7
Non-visualization	3	2
Stones		
Radiolucent	4	2
Radiopaque	..	2
Mixed	..	1

in approximately 80 per cent, and that the 2-gm. dosage is then satisfactory for the entire weight range. A very dense gallbladder shadow was observed in the heaviest patient in the series (236 lb.) and multiple stones were demonstrated in a 205-lb. patient. It is felt, therefore, that adjustment of dosage to patient weight is not indicated, justifying the more easily carried out routine dosage.

The routine 2-gm. dosage of Telepaque for cholecystography thus appears to have the advantage of economy in the use of contrast material, slight reduction in the more frequently encountered side effects, reduction in the number of extremely dense gallbladder shadows without significant reduction in the overall number of diagnostic shadows, and adequate density of gallbladder shadows over the entire patient weight range.

SUMMARY

1. With a routine 2-gm. dosage of Telepaque for cholecystography the more frequently encountered side-effects were reduced 4 to 5 per cent as compared with an earlier series receiving 3 gm.

2. Reduction in the number of extremely dense gallbladder shadows was noted, but the overall decrease of satisfactory diagnostic shadows was only 4 per cent; this is counterbalanced by the decreased risk of obscuring biliary calculi by the extremely dense shadows more frequently seen with the 3-gm. dosage.

3. The 2-gm. dosage is satisfactory for the clinically encountered range of patient weights, and no adjustment for the heavier patients is needed.

4. For established routine in a large institution where a great number of colecystograms are taken, Telepaque in 2-gm. dosage is entirely satisfactory.

NOTE: The authors wish to express their appreciation to Dr. F. J. Hodges for his aid in planning and carrying out this study, and to Winthrop-Stearns, Inc., for supplying the Telepaque.

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SUMARIO

Justipreciación Clínica y Roentgenológica de la Dosis Sistemática de 2 Gm. de Telepaque en la Colecistografía

Con una dosis sistemática de 2 gm. de Telepaque para la colecistografía, se rebajaron a 4–5 por ciento, en comparación con una serie anterior que recibió 3 gm., los efectos colaterales observados más frecuentemente. Se notó disminución del número de sombras sumamente densas de la vesícula biliar, pero la disminución global de las sombras satisfactorias para diagnóstico no pasó de 4 por ciento. Queda esto contrarrestado por el menor riesgo de que los cálculos biliares queden obscurecidos por las sombras sumamente densas observadas más a menudo con las dosis de 3 gm.

La dosis de 2 gm. resulta satisfactoria para los pesos de los enfermos que se suelen encontrar en la clínica, y no se necesita ajuste para los sujetos más pesados. Para el régimen establecido en una institución grande en que se toma un gran número de colecistogramas, el Telepaque a dosis de 2 gm. es absolutamente satisfactorio.

A Comparative Clinical Study of Teridax (3 Gm.) and Telepaque (2 Gm.) in Routine Cholecystography[1]

WALTER M. WHITEHOUSE, M.D.[2]

FOLLOWING intensive comparative investigations of Priodax and Telepaque in varying doses under controlled circumstances for evaluating both the clinical side-effects and the roentgenographic efficacy, it was determined that, for routine use in a large institution, Telepaque in 2-gm. dosage constituted our cholecystographic medium of choice (1, 2). The subsequent introduction of Teridax necessitated further comparative studies to assess the possible advantages of this newer medium under identical conditions.

Attention has been called to the potential disadvantages of Telepaque, namely, the presence of unabsorbed or excreted contrast material in the colon, which might obscure a portion of the gallbladder, and the intense opacification, which might obscure included stones. Inasmuch as Teridax is excreted almost completely in the urine and does not result in as dense gallbladder opacification, early reports emphasized the advantages of this medium in avoiding these difficulties.

The chemical structure of Teridax—3 (3 hydroxy-2,4,6 triiodophenyl) 2-ethyl propionic acid—and Telepaque—3(3-amino-2,4,6 triiodophenyl) 2-ethyl propionic acid—indicate that they are closely related chemically and have approximately the same iodine content.

The tabulation of side-effects was accomplished by questioning patients in conjunction with the taking of a history just prior to combined cholecystography and upper gastrointestinal examination. The resultant cholecystograms were evaluated according to the scale used in previous studies, the gallbladder shadows being classed as excellent, good, faint, or non-visualization, with a notation as to the type of stones demonstrated. No side-effects were noted in 110 (71 per cent) of 155 cases. This is in fair agreement with the 77.5 per cent patients without side-effects in an early series elsewhere (3). The side-effects encountered in the present study are shown in Table I, where they are compared with those observed in the author's previous series with Telepaque (2).

TABLE I: SIDE-EFFECTS WITH TERIDAX (3 GM.) AND TELEPAQUE (2 GM.)

	Mild		Severe	
	Teridax, 3 gm.	Telepaque, 2 gm.	Teridax, 3 gm.	Telepaque, 2 gm.
Nausea	12.3%	6.6%	1.9%	0.4%
Vomiting	1.3%	2.2%	0.6%	0.2%
Diarrhea	9.7%	17.6%	0	0.4%
Dysuria	9.7%	9.0%	0	0.4%
Other	4.5%	4.2%	0	0.4%

No side effects: Teridax 71.0 per cent. Telepaque 66.2 per cent

The side-effects of Teridax grouped under "other" include headaches in 3 cases, and dizziness, epigastric burning, gas, and abdominal cramp in 1 each. It is noted that the incidence of nausea and dysuria is slightly higher than in Teridax series reported by others (3, 4), but it is to be emphasized that these manifestations were mild in degree and that evaluation of such subjective sensations are difficult and may be considerably influenced by the manner of interrogation, which was the same as used in tabulating the comparative values for other media.

To be noted is the slight overall advantage of Teridax in the number of asymptomatic patients, the slight increase in mild nausea with Teridax, and the more marked decrease in diarrhea with Teridax.

In the 140 cases for which films were available, gallbladder visualization was classified as "excellent" (a dense gallbladder shadow), "good" (a diagnostic shadow which is not dense), faint, and

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TABLE II: GALLBLADDER VISUALIZATION WITH TERIDAX (3 GM.) AND TELEPAQUE (2 GM.)

	Teridax, 3 gm.	Telepaque, 2 gm.
Excellent	9.3%	46.6%
Good	42.2%	32.6%
Faint	27.1%	10.2%
Non-visualization	21.4%	9.4%

non-visualization. The results are shown in Table II, again with comparative data on Telepaque.

It is of interest that a series of 500 cases with Teridax was originally planned, and the rather marked difference in density of the gallbladder shadow, as indicated above, was shown early in the series. Considerable dissatisfaction with the resulting cholecystograms was expressed by both clinical and radiologic colleagues, and the series was terminated sooner than planned in deference to their mounting objections. It appears that the objective evaluation of gallbladder visualization corroborates their subjective impression.

It may be, of course, that the degree of opacification of the gallbladder observed with Teridax in 3-gm. dosage is a more sensitive indication of gallbladder function than is the more intense opacification with Telepaque in 2-gm. dosage. This possibility can be determined only when there is available a large series of surgical cases examined with both media. Until then, it would appear that the higher incidence of faint shadows and non-visualization with Teridax in 3-gm. dosage is a disadvantage, particularly in the demonstration of radiolucent stones. In this group of patients, 9 were found to have stones—3 opaque, 4 radiolucent, 2 mixed—and in 3 others there was questionable evidence of stones. A very slight trace of granular opaque material otherwise unaccounted for was noted in the colon in 12 cases, or 8.2 per cent. This is in marked contrast to the extremely high percentage (97.4) of Telepaque (2 gm.) cases showing residual or excreted contrast medium in the colon.

Forty-two cases in the present series were also examined with Telepaque in 2-gm. dosage. The distribution of the relative density in these cases was as follows:

More dense with Telepaque	22
Density similar	11
Less dense with Telepaque	1
Non-visualization with both	8

It is of interest that of the 22 cases which showed more dense visualization with Telepaque (2 gm.), 8 were cases in which only faint visualization or none at all was obtained with Teridax. Of 8 cases previously examined with Priodax (3 gm.), 5 showed more dense shadows with Teridax.

DISCUSSION

The possible advantages in the use of Teridax, as indicated in previous reports (3, 4), are the lower incidence of side-effects, less dense gallbladder opacification, and relative infrequency of contrast material in the adjacent colon. It has been demonstrated (2) that the intensity of gallbladder opacification initially observed with 3-gm. Telepaque dosage can be reduced by using a 2-gm. dose routinely, and that this does not significantly increase the number of faintly and non-visualized cases. It would appear that reducing the Telepaque dosage is a more adequate measure for achieving reduction in intensity of the gallbladder shadow than changing to Teridax, inasmuch as use of the latter doubles the incidence of faint shadows and non-visualization. It is also to be emphasized that the obscuration of an opaque stone by an opacified gallbladder is a relatively rare event and can be effectively counterbalanced by adequate inspection of the right upper quadrant in scout filming.

The presence or absence of contrast material in the colon has two facets for consideration. When the colon overlies the gallbladder, the opaque granular material may cause confusion. On the other hand, the presence of the characteristic granular material in the colon serves as a positive indication that the patient has ingested the medium as directed. It has been our experience that the amount of granular contrast in the colon has been reduced with the reduction of Telepaque

dosage and only rarely causes confusion. When the colon overlies the gallbladder on the film, gas shadows are more apt to be confusing, making it difficult to exclude radiolucent stones. This source of confusion is occasionally present with both Telepaque and Teridax.

In view of these findings, it is our opinion that, in spite of the decreased side-effects with Teridax in 3-gm. dosage, the diminution in gallbladder density increases the number of faintly and non-visualized gallbladders to an undesirable degree. We also feel that the absence of contrast material in the colon may be a disadvantage in that there is no film evidence that the patient has actually ingested the contrast medium if his gallbladder is not visualized. In view of these considerations, it is our continued opinion that Telepaque in 2-gm. dosage remains the oral cholecystographic medium of choice for routine work.

SUMMARY

1. The introduction of Teridax necessitates a reconsideration of the medium of choice for routine oral cholecystography. A series of 155 patients receiving Teridax (3 gm.) is compared with a previous Telepaque (2 gm.) series of 500 patients.

2. The incidence of asymptomatic patients was higher with 3 gm. Teridax (71 per cent) than with 2 gm. Telepaque (66.2 per cent). The incidence of diarrhea was decreased.

3. The number of dense gallbladder shadows was markedly reduced in comparison with Telepaque, 2 gm., but the incidence of faintly and non-visualized gallbladders was more than doubled.

4. Which spectrum of opacification of the gallbladder most nearly represents the variation of function of that organ remains a matter of conjecture and must await the accumulation of larger series of surgical pathologic material.

5. Of 42 patients examined with both media, 22 showed denser shadows with Telepaque, 11 similar density, 1 less density, and 8 non-visualization with both.

6. The incidence of contrast medium in the colon is much less with Teridax. This is thought to be a disadvantage in cases of non-visualization. Overlying gas in the colon continues to be a problem with both media.

7. Obscuration of opaque stones by dense opacification is a relatively rare occurrence and may be counterbalanced by adequate scout filming.

8. In the opinion of the author, Telepaque in 2-gm. dosage achieves some reduction in density of the gallbladder shadow and colonic residuum without the more marked reduction in density and colonic residuum seen with Teridax (3 gm.), and these considerations are felt to outweigh the decreased side-effects of Teridax. Telepaque in 2-gm. dosage remains therefore, the routine cholecystographic medium of choice.

NOTE: The author wishes to express his appreciation to the Schering Corporation for the Teridax used and for their approval for the initiation of this comparative study.

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(Para el sumario en español véase la página siguiente.)

SUMARIO

Comparativo Estudio Clínico del Teridax (3 gm.) y del Telepaque (2 gm.) en la Colecistografía Corriente

La introducción del Teridax impone una reconsideración del medio de elección para la colecistografía oral corriente. Compárase aquí una serie de 155 enfermos que recibieron Teridax (3 gm.) con una serie anterior de 500 que recibieron Telepaque (2 gm.).

La incidencia de enfermos asintomáticos fué mayor (71 por ciento) con 3 gm. de Teridax que con 2 gm. de Telepaque (66.2 por ciento). También disminuyó la incidencia de diarrea.

Bajó decididamente la proporción de sombras densas de la vesícula biliar en comparación con el Telepaque, pero pasó del doble la incidencia de vesículas visualizadas débilmente o no visualizadas.

Sería pura conjetura deducir qué espectro de opacificación de la vesícula biliar representa mejor la variación en las funciones de dicho órgano, y esto tendrá que esperar hasta que se acopien series más grandes de material patoquirúrgico.

De 42 enfermos examinados con ambos medios, 22 revelaron sombras más densas con Telepaque, 11 densidad semejante, 1 densidad menor y 8 falta de visualización con ambos.

La incidencia del medio de contraste en el colon es mucho menor con Teridax, lo cual parece ser una desventaja en los casos de falta de visualización. El gas sobreyacente en el colon continúa siendo un problema con los dos medios.

El oscurecimiento de los cálculos opacos por una opacificación densa es un hecho relativamente raro y puede contrarrestarse con adecuadas radiografías exploradoras.

A parecer del A., Telepaque a dosis de 2 gm. logra alguna disminución de la densidad de la sombra de la vesícula biliar y del residuo colónico sin la reducción mas notable de la densidad y del residuo colónico observada con Teridax (3 gm.), y estas consideraciones parecen sobrepujar la reducción de efectos colaterales observada con Teridax. El Telepaque a dosis de 2 gm. continúa siendo el medio colecistográfico corriente de elección.

An Experimental Study of Zirconium Compounds in Contrast Radiography[1]

ROBERT SHAPIRO, M.D.

THE PUBLICATION of several recent reports suggesting the use of zirconium for contrast radiography (3, 6) prompts us to publish our experience with this element.

Zirconium is element number 40, with an atomic weight of 91.2. The metallic element does not occur free in nature, but is commonly obtained as the silicate, oxide, etc. Zirconium minerals, chiefly zircon ($ZrSiO_4$), are found in alluvial deposits derived from igneous rocks. Zircon is a heavy crystalline material with low solubility and remarkable refractory properties. It has been used industrially as a substitute for silica and sand.

Zirconium is usually quadrivalent, although occasionally it is bivalent, as in zirconium hydride (ZrH_2). Hydrated zirconium oxide is amphoteric in that it acts both as an acid and as a base. In general, there are three principal types of zirconium salts.

1. The normal salts in which the zirconium acts as a quadrivalent cation in combination with the radicles of the stronger acids, *e.g.*, $Zr(SO_4)_2$.

2. A series of basic salts in which the bivalent zirconyl radicle (ZrO) acts as a base. These salts can often be considered as intermediates in the progressive hydrolysis of the normal salts.

3. A series of zirconates or metazirconates in which the zirconyl hydroxide ($Zr(OH)_2$) acts as an acid (metazirconic acid (H_2ZrO_3)). There is a tendency for the acid to form polyzirconates analogous to the polysilicates.

The use of zirconium compounds for contrast radiography is not new. As early as 1909, Kaestle (4) advocated insoluble zirconium oxide (ZrO_2) as a contrast medium for the gastrointestinal tract. In 1948, McClinton and Schubert (6) briefly alluded to this substance for the same purpose. Hunter and his coworkers (3) in 1949 reported their experience with sodium zirconyl citrate as a radiopaque medium and commented upon the promising future of such compounds.

A review of the chemistry and biology of zirconium suggests that this element might be an ideal contrast medium, since it is relatively non-toxic and has none of the disadvantages of the organic halogen derivatives. Kaestle found no toxicity following the subcutaneous injection of 400 mg. of a soluble zirconium salt into rabbits, and Harding (2) injected a finely divided 10 per cent suspension of zirconium silicate intravenously, intraperitoneally, and intratracheally without toxic effect. Schubert and his associates (6–10) confirmed the low toxicity of various soluble zirconium salts in rats. These investigators observed no toxic effects following injection of as much as 210 mg./kg. of zirconium citrate intravenously in a single dose and 1,336 mg./kg. in multiple doses. Cochran *et al.* (1) administered a number of zirconium salts to rats (sodium zirconyl sulfate, zirconyl acetate, nitrate, sulfate and chloride) and also confirmed their low toxicity. Of the various compounds studied, sodium zirconyl sulfate (25 per cent solution) was the least toxic. (Oral LD 50, 10,000 mg./kg. of the compound; intraperitoneal LD 50, 4,100 mg./kg.).

We were primarily interested in two principal zirconium compounds: a 25 per cent aqueous suspension of zirconium oxide for hepatolienography, and a 25 per cent aqueous solution of zirconium glycolate and lactate for bronchography, myelography, intravenous pyelography, etc. We were able to corroborate the low toxicity

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of both compounds administered orally and intraperitoneally. However, the intravenous injection of the zirconium oxide suspension in guinea-pigs and rabbits consistently produced pulmonary infarction and death. Postmortem studies on these animals showed multiple pulmonary emboli consisting of grossly particulate microscopic examination of the suspension showed clumping, with aggregates measuring as much as 15–150 μ. In a few animals that lived for several minutes, some of the zirconium oxide was deposited in the reticuloendothelial cells of the liver and spleen, but the density on the roentgenogram was not great.

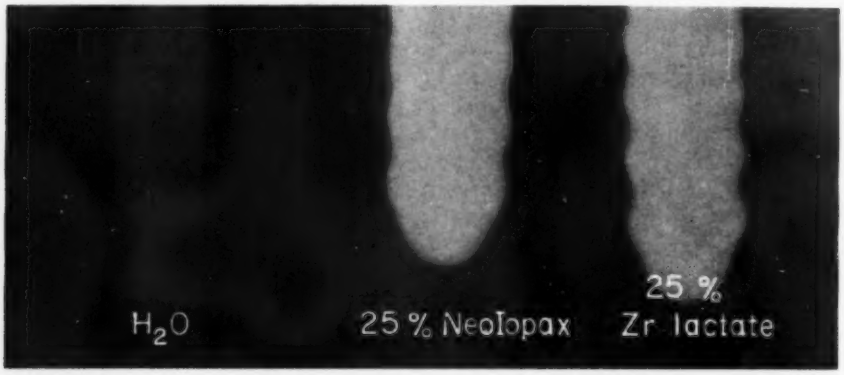

Fig. 1. Radiograph in air, at 30 kvp, of finger cots containing water, Neo-Iopax, and 25 per cent zirconium lactate. Note similarity of densities of the Neo-Iopax and the zirconium compound.

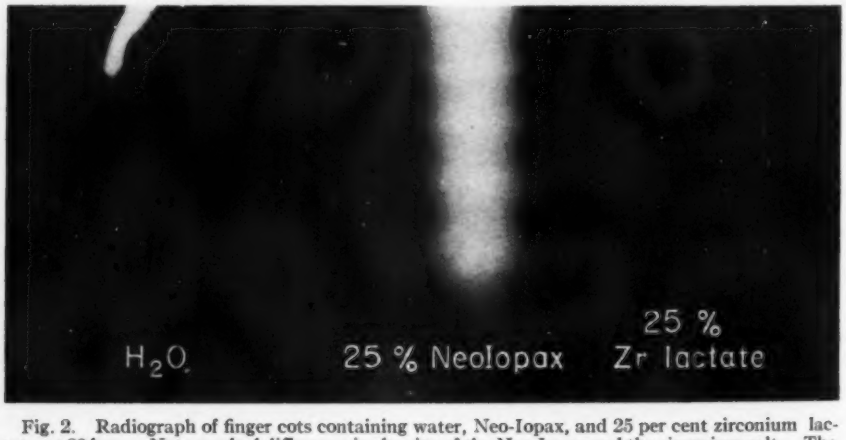

Fig. 2. Radiograph of finger cots containing water, Neo-Iopax, and 25 per cent zirconium lactate, at 80 kvp. Note marked difference in density of the Neo-Iopax and the zirconium salt. The finger cot containing water is not visible at all.

zirconium oxide. This is not an indictment of the zirconium itself but is due to our inability to prepare a stable colloidal suspension. Although the particles averaged 3–5 μ when the suspension was initially prepared, they tended to settle out upon standing. The heavy white sediment which formed could be re-suspended by mechanical agitation, but

The sodium zirconyl glycolate and lactate solutions were instilled into the trachea in dogs which had been anesthetized by intravenous Sodium Nembutal. These solutions were utilized both in pure form and with sodium carboxymethylcellulose added as a thickening agent. In either instance, the compound was rapidly absorbed from the tracheobronchial tree with-

out demonstrable toxicity. Because most of the material was absorbed within two to three minutes, only spot films could be made, and the radiopacity was not sufficient for satisfactory interpretation.

On the other hand, roentgenograms in air and water phantoms of finger cots containing these compounds and equal aliquots of 25 per cent Neo-Iopax showed surprisingly little difference in opacity at 30 to 50 kvp (Fig. 1). Roentgenograms made at 80 kvp under similar conditions showed a marked difference in opacity between the zirconium and Neo-Iopax solutions (Fig. 2). This apparent paradox can be resolved on the following physical basis (5):

$$\mu = k\,\lambda^3 Z^4 + 0.2$$

where μ is the absorption coefficient; k is a constant; λ is the wave length of the radiation; Z is the atomic number of the element; 0.2 is the coefficient of scattering, which varies only slightly with the wave length.

In the voltage range commonly used in diagnostic radiography, absorption is principally due to the photoelectric effect. The tube voltage is important, because absorption is proportional to the cube of the wave length. Similarly, being proportional to the fourth power of Z, absorption increases markedly for the heavier elements. In the 70 to 90-kvp range, a large portion of the radiation in the heterochromatic beam falls where zirconium absorbs but little. In contrast to this, at lower kilovoltages (30–40 kvp used for radiography of small animals and solutions in test tubes) a relatively greater quantity of radiation falls in the K absorption peak for zirconium. This accounts for the relatively greater radiopacity at lower kilovoltage. Actually in the 70 to 90 kvp range, a given number of atoms of zirconium absorb only about 35 per cent as much radiation as an equal number of iodine atoms. For this reason, zirconium is not satisfactory as a radiopaque contrast agent in man.

SUMMARY

1. The pertinent chemistry of zirconium is reviewed.

2. In animal experiments, both soluble and insoluble zirconium compounds have been found to be relatively non-toxic.

3. Roentgenograms, in air and water phantoms, of finger cots containing zirconium compounds showed these to be unsatisfactory for contrast radiography in man. The physical basis for this conclusion is presented.

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SUMARIO

Estudio Experimental de los Compuestos del Zirconio en la Radiografía de Contraste

Los experimentos realizados en animales con una suspensión acuosa de óxido de zirconio (al 25 por ciento) y con soluciones acuosas de glicolato y lactato de zirconio revelaron que estos compuestos poseen poca toxicidad cuando se administran oral o intraperitonealmente. Las soluciones de glicolato y lactato fueron introducidas intratraquealmente en perros, siendo absorbidas rápidamente sin efecto tóxico. La rápida absorción impidió hacer satisfactorios estudios radiográficos, pero las radiografías de los dediles que contenían dichos compuestos llevaron a los AA. a la conclusión de que no son aquéllos satisfactorios para la radiografía en el hombre. Preséntase la base física en que se apoya esa conclusión.

Production of Cataracts in Animals by X-Rays and Fast Neutrons[1]

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OUR PARTICULAR interest in ionizing radiation of various types stems from the relationship between exposure to such sources of energy and the subsequent occurrence of cataract. In the initial work with x-rays, instances of cataract in both the operator and the patient were observed, but as technics improved, the hazard became more and more limited to the patient. Continued experience demonstrated that additional shielding of the patient's eye could often be effectively used, and that fractionation of the total dose into repeated smaller doses would further reduce the incidence of radiation cataract. When large eye doses are necessary, cataract production usually becomes relatively unimportant, since the eye may be more seriously damaged by the secondary glaucoma that may follow irradiation.

Although the cataractogenic dosage is of interest to all who work with x-rays, it is not possible to say exactly what it is in all conditions of exposure. Cataract may be partial, interfering little or not at all with vision, or it may become dense (or complete), so that no useful vision is possible. The extent of opacification depends primarily upon the quality and quantity of irradiation received, but the effect is lessened when the total dosage is divided into smaller units given over a longer period of time. Perhaps the average young adult would get a complete cataract from 2,500 to 4,000 r of 250-kv radiation (filtered with copper and aluminum), while only 500 to 1,000 r at 125 kv (aluminum filter) might result in at least partial opacity. Young persons would be injured by smaller dosages, while old people would be resistant to such exposures.

Cataract following roentgen irradiation need no longer be a hazard to the x-ray worker, as the potential danger has been recognized and adequate shielding can be provided. During research in development of nuclear energy, some workers were accidentally exposed to neutron radiation, with later cataract formation (1). The nature of the exposure was known with sufficient precision to indicate that the cataracts were the result of irradiation of the eye region. The number of these accidents was small, but it alerted scientists to the danger to the lens entailed by such irradiation. As the result of atom bomb explosions in Japan, more information concerning the effects of neutrons on the lens has been accumulated (2, 3). From these data it is possible to conclude that the cyclotron worker, for example, is in danger of cataract formation unless he uses the protective measures available.

Although the usual results of both acute and chronic whole-body exposures to radiation are serious general disturbances, it is possible that the only manifestation of radiation injury may be the development of lens changes. This is particularly true when there is repeated exposure of the head to low dosages over a long period of time. The importance of the cataract problem caused the National Research Council, with the support of the Atomic Energy Commission, to set up a Radiation Cataract Committee. The purpose of this group was to bring together physicists, biologists, and ophthalmologists, in order to correlate their efforts in study and research concerning the occurrence of cata-

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ract from x-ray and neutron radiations. Under this sponsorship, research projects have been supported, and meetings for the exchange of ideas between researchers in the field have been arranged. So far, five general conferences[2] have been held and the views of the scientists in the various specialties have been correlated. Much of the fundamental research has been on the physical and biologic aspects, while the ophthalmologists have contributed data concerning the morphology and developmental characteristics of radiation cataract. The biochemist has utilized the lens as a tissue wherein the intimate reactions of ionizing radiation with the cell can be measured (4).

In order to study adequately the effects of radiation on the lens, animal research was mandatory. Rabbits, mice, and rats have been most frequently used, but dogs and monkeys have been utilized in some recent experiments. Our own work has been with mice and rabbits. The varied appearance of the cataracts produced by different dosages and types of x-ray was discussed by Leinfelder and Kerr in 1936 (5), at which time it was pointed out that tissue changes indicated injury to the growing cells at the equatorial region of the lens.

When the cataractous effect of neutrons was demonstrated, the similarity to the effects of x-rays was noted (6), and it appeared desirable to establish a factoral relationship between neutrons and roentgen rays. Early investigations (6) suggested an effectiveness ratio of perhaps ten to one, as measured by the ionization chamber (neutrons being most cataractogenic). Recent studies (7) indicate that higher energy neutrons behave differently; they have not yet been evaluated in terms of x-ray effects.

The cataracts that result from neutron radiation injury, as from x-rays, may be partial or complete. In man and in experimental animals both types are produced, and the degree of opacity is ordinarily correlated with the dosage received The visible changes in the lens occur only after a latent period of several weeks or months. This time interval is longer when smaller dosages are used. If the lens receives a moderate to large amount of radiation, the initial changes will appear in four to eight weeks. These are seen as small bubble-like opacities in the periphery of the lens, at the equator, where growth continually occurs (8, 9). These increase in number and slowly move toward the posterior pole of the lens. When moderate doses have been used, a stationary opacity in the posterior subcapsular region results. Following large doses there is continuous formation of vacuoles in the equatorial region, and as these continue to move toward the posterior pole, other opacities of a similar nature appear in the anterior portion of the lens. A slight diffuse cloudiness of the entire lens follows, increasing slowly. Complete opacity gradually develops, and four to six months after the appearance of the first opacities the lens may be completely opaque.

Small doses sometimes cause transient vacuoles in the cortex. These may later disappear; in other instances they lead to the formation of fine dots that outline the sutures of the posterior subcapsular region and remain as permanent but stationary changes. Such slight opacities occur when the dosage is just above threshold; as the intensity of radiation dosage is increased, a greater and greater effect is observed. In all instances, however, there is a latent period, usually followed by peripheral changes that finally lead to partial or complete opacification of the lens. In mice, posterior subcapsular vacuoles are first seen; these remain relatively stationary or gradually increase and finally result in complete opacity.

The cause of radiation cataract is still not precisely known. For many years some investigators believed that the damage in the lens was secondary to radiation injury to the ciliary body. Many, however, were certain that the effects were en-

[2] See Abstracts and Proceedings of the Five Conferences on Radiation Cataracts. National Research Council, Washington, D. C.

tirely in the lens, and experiments to demonstrate this were devised. Von Sallmann (10) observed the direct effects of x-rays on the mitotic index of the lens epithelium, and Goldmann and Liechti (11) and Alter and Leinfelder (12) produced cataracts when the lens was irradiated, but not when the ciliary body was exposed and the lens protected. More recently Puntenney and Shoch (13) partially confirmed these results, but offered evidence that injury to the ciliary body may play a role. Some of these results also demonstrated the special sensitivity of the equatorial portion of the lens (11, 12) and showed that irradiation of one part of the lens caused partial cataract in that region only.

From these experimental data, it is possible to postulate that ionizing radiation injures (primarily) the growing cells of the lens epithelium. Although a few cells are killed, the main observable effect seems to be upon mitosis. The rate of mitosis is definitely retarded, but in addition some change appears to take place that prevents the production by the cell of a normal lens fiber. As growth of the lens continues, distorted and aberrant fibers are formed that disturb the otherwise homogeneous pattern of the lens and form an opacity. If many cells are injured, many abnormal fibers (vacuoles) are formed, and the amount of this abnormal growth determines whether there will be a partial or complete cataract. The cataract in its early stages is not a manifestation of death of tissue but rather of the perverse growth of cells, forming abnormal tissue. Eventually, changes in the entire lens occur, but this is only after many abnormal lens fibers have been formed.

The specific effect of ionizing radiation upon the lens is not known. A relationship between oxidation and reduction ratios is indicated by the protective action of cysteine upon the lens epithelium of irradiated animals (14, 15). It has been suggested that the cysteine competes for the oxidizing effect of the radiation and thus spares the lens cells.

It has been known for some time that fast neutrons are in many instances more biologically effective than x-rays (16–20). The effectiveness of fast neutrons has been generally considered to be from four to ten times that of high-voltage x-radiation and gamma radiation. It has been found more recently that particular organs may be especially sensitive to the dense ionization produced by fast neutrons. Among other tissues, the lens of the eye is especially susceptible to this form of radiation. It was observed in experiments with the Columbia University cyclotron that whole-body x-ray exposures, sufficient to kill 50 per cent of the irradiated mice (LD 50), would not produce cataracts in the survivors even though they lived for several months. However, when mice were similarly exposed to fast neutron irradiation, a high incidence of complete cataracts was observed in animals surviving the LD 50 exposure (6, 21). This was one of the first indications of the greater susceptibility of the lens to fast neutron irradiation. In a particular strain of mice, it was found that the RBE (relative biologic effectiveness) for fast neutrons (about 4-Mev neutrons from a cyclotron) as compared to x-rays was about 4 for the LD 50. The RBE for the production of cataract was found to be higher than this (approximately 8). This was for single exposures. Later it was found that, when the total radiation was given in small daily fractions, the RBE increased to still higher levels (22, 7). More recently, the present authors found that the RBE for a second cyclotron (University of Chicago) was about 2.5 for the LD 50 (mice), and that the fast neutrons had an RBE of about 5 for cataract production in single exposures. Following weekly and monthly exposures, the RBE of these fast neutrons increased to about 8. Therefore, although the absolute values were different, the relative effects appear to be the same as in the earlier work. This would seem to indicate a greater RBE for fast neutrons for general effects and especially for cataract. The earlier finding of greater recovery (as regards cata-

ractogenic action) between x-ray exposures was also confirmed. These relations were found to hold also for rabbits, although the latent period was much longer than for mice, and the lens opacities were not as extensive within similar dosage ranges.

A third cyclotron (at Argonne National Laboratory) has been utilized as a source of fast neutrons, and these radiations seem to vary in effectiveness, depending upon the energy of the neutrons. Although the investigators are still in the process of determining the energy values, it is assumed that the fast neutrons from the forward beam of this cyclotron are much more energetic than those from the beam coming from the back of the target. The results seem to indicate that the higher the energy of the neutrons (from 4 Mev to about 15 Mev), the less the biologic effect, both for the LD 50 and for cataract production. Therefore, in comparing the relative biologic effectiveness of fast neutrons and of x-rays, there are apparently four factors to consider: (*a*) The linear energy transfer of fast neutrons, being higher than that for x-rays, causes the LD 50 to be much lower for the same number of rep (or rad) in neutrons than for high-voltage x-rays. (*b*) Some tissues exhibit this greater effectiveness of neutrons more definitely than do other tissues. One of the most evidently sensitive organs is the lens of the eye. (*c*) The lens of the eye appears to recover little if any from fractionated neutron treatment, so that a comparison based on fractional exposures gives a much higher RBE than those based on single exposure. (*d*) Preliminary evidence seems to indicate that an optimum linear energy transfer (or density of ions per unit path of the particle) may be demonstrated for the production of lens opacities.

There is not complete agreement, however, among all investigators concerning the nature, type, and degree of the effects of x-rays and neutrons on the lens. This is due to the difficulties in measuring dosage, the use of animals of varied age and species, and the problem of interpreting partial changes in the lens. Furthermore, different sources and methods of irradiation produce quite different results. Thus, in evaluating the work of any researcher, it is necessary to consider the results in terms of the source of radiation, the species of animal, and the technics used by the investigators.

CONCLUSIONS

1. Radiation cataract is a real but not a vital hazard.
2. In most instances it can be avoided by the use of proper precautions.
3. With lower dosages, progressive changes are not as likely to occur as with higher exposures.
4. The development of radiation cataract demonstrates some of the mechanisms of biologic actions of ionizing radiation.
5. Cataract is a more likely hazard for neutron workers than for those who may be exposed similarly (clinically) to x-radiation.

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SUMARIO

Producción de Cataratas en los Animales con los Rayos X y con Neutrones Veloces

Las observaciones sumarizadas derívanse del estudio de la catarata por irradiación producida por los rayos X y por neutrones en ratones y conejos. Lo mismo que en el hombre, así también en el animal de experimentación las cataratas irradiatorias pueden ser parciales, que afectan poco o nada la visón, y totales, que no dejan visión útil. La intensidad de la opacidad se correlaciona ordinariamente con la dosis recibida. Se describe el aspecto clínico de la catarata por irradiación en vías de formación.

La relativa eficacia biológica de los rayos X y los neutrones, según se observara en los animales de experimentación, varía algo de acuerdo con la energía de los neutrones veloces empleados. Los resultados parecen indicar que mientras más alta es la energía de los neutrones menor es el efecto.

DISCUSSION

Andrew H. Dowdy, M.D. (Los Angeles, Calif.): It was a pleasure to hear Dr. Leinfelder present this paper prepared in association with Dr. Titus C. Evans and Dr. Riley. If my memory serves me correctly, Dr. Evans started working on this cataract problem some twelve years ago and has worked more or less continuously on it ever since. Perhaps, from the radiological, biological standpoint, he has done more work on this particular problem than anybody in the country, and I feel flattered to be asked to discuss it, because the interest that I have had in cataracts has not been a passing one but incidental to other studies which we have carried out.

In looking over the paper, it was difficult to find anything to ask a question about or even to criticize. There are, perhaps, two points that may be brought out. One is that with proper protection there is no longer any real hazard to the operator or to those working with radiation. It is only under circumstances in which the eye is involved, where one cannot shield properly, that one is likely to obtain a clinical cataract. As a matter of fact, I think that perhaps in my brief

span of some fifteen or twenty years, I have only produced one or two cataracts, and these were both in patients with a lesion either involving the eye or so close to the eye that there was a certain amount of back-scatter. It is well known that the x-rays of the lower voltages are more likely to produce cataracts than are the higher energies. This is due to the degree of specific ionization which takes place in the lens or, to put it another way, it is the amount of energy which is absorbed.

The authors state that the higher the energy from the neutron, perhaps the less effect. It is known that very slow neutrons do not produce cataracts as readily as those of a little higher energy. I would assume, from what Dr. Leinfelder says, that there is perhaps an optimum energy for producing cataracts with neutrons. I would like to ask if they have determined this optimum energy.

G. Failla, D.Sc. (New York): The statement has been made that cataracts are amenable to treatment. I am interested to know what sort of treatment is in view.

Dr. Leinfelder (*closing*): The optimum energy for production of cataracts is not known. As a matter of fact, recent work in our laboratory has demonstrated the difference in the cataractogenic nature of neutrons from different sources. In our experiments we have used four different sources of neutrons. The cataractogenic effect has varied with the energy of their production. It is not possible at this time to state that there is a direct relationship between occurrence of cataract and energy absorbed through radiation.

It has been a matter of concern to some physicists that a roentgen or a neutron cataract might offer more hazard in removal and treatment than any other type of cataract. There is no reason why cataracts from various causes—senile cataracts, diabetic cataracts, x-ray cataracts, neutron cataracts—cannot be removed with equal facility.

The hazard that exists is dependent upon the source of radiation. The danger of exposure to the worker and patient in the x-ray field is entirely different from that in the neutron field. The x-ray worker is in no danger, while the neutron worker is in danger unless he uses all precautions.

EDITORIAL

Invitation to the Annual Meeting

The Forty-first Annual Meeting of the Radiological Society of North America will be held at the Palmer House in Chicago, Dec. 11–16, 1955. You and your friends are most cordially invited to attend. I did have hopes of inviting you to the Southwest, but this Society has grown so large that only a few cities have the resources to accommodate the Scientific Programs, Refresher Courses, Scientific and Commercial Exhibits. You are all familiar with the facilities of the Palmer House and the cooperation of the management, which goes a long way in making the meeting a success. The radiologists in Chicago and the vicinity, as well as others of the medical profession, are most liberal in their support and put forth every effort to make us feel at home.

Dr. John W. Walker, whose committee has so ably handled the Refresher Courses, has been called into the Armed Forces. Dr. Robert D. Moreton is serving as chairman of this committee and has arranged a most interesting and instructive series of courses, beginning Sunday afternoon and evening and continuing daily, 8:00 to 10:00 A.M.

The Scientific Sessions will be divided into four sections: Section A, Clinical Radiology; Section B, Radiophysics and Radiobiology; Section A-B, Panel discussions of Clinical Radiology; Section C, Radiologic Physics.

Dr. Ivan J. Miller, Chairman of the Committee on Scientific Exhibits, has secured additional space, which will permit a better display and accommodate more exhibitors.

Dr. John H. Gilmore, Chairman of the Commercial Exhibits Committee, will also have additional space so that the manufacturers may better display their apparatus.

The Annual Carman Lecture will be given by Dr. Axel Norman Arneson of St. Louis. Dr. Arneson is a former Texan and a native of Fort Worth.

The Business Sessions of the Society will be held on Monday, Tuesday, and Thursday afternoons. Time will be given for due deliberation of the Society business.

Dr. Elbert K. Lewis is Chairman of the Local Arrangements Committees. Dr. David S. Beilin is in charge of the entertainment committee. The social functions for the ladies are in the most capable hands of Mrs. Elbert K. Lewis, Mrs. Warren W. Furey, Mrs. John H. Gilmore, and their committees. We sincerely hope that your wives will accompany you.

Your officers extend to you their greetings and hope to have the pleasure of seeing you in Chicago in December.

TOM B. BOND, M.D.
President

REFRESHER COURSES: POSTGRADUATE INSTRUCTION

The 1955 Refresher Course Series will be presented during the Forty-first Annual Meeting of the Radiological Society of North America at the Palmer House, Chicago, Ill. The courses will open at 2:30 P.M., Sunday, Dec. 11, and this opening session will be followed by a Film-Reading Session at 7:00 P.M. Commencing on Monday, Dec. 12, there will be nine courses daily from 8:30 to 10 A.M. No other meetings will be scheduled during these hours. Attendance is limited to the medical profession, including graduate students and residents in radiology; radiation physicists, radiobiologists, chemists and others closely concerned with the science of radiology; and medical students certified by the deans of their respective medical schools.

A registration fee of $15.00, which includes the Refresher Course fee, must be paid by all nonmembers of the Radiological Society of North America at the time of registration at the Palmer House. The exceptions are guest speakers, guest instructors, scientific exhibitors, residents or fellows in radiology, medical students, trainees in physics, and officers in the Armed Forces of the United States on temporary duty and away from their practice. Members of the Radiological Society of North America do not pay a registration fee or a Refresher Course fee. All must register at the R.S.N.A. registration desk in the Palmer House. Admission to the Refresher Courses will be by presentation of the registration badge and a ticket for the particular course. Payment of the registration fee by non-members *is not* to accompany the request for tickets but is to be made when the tickets are called for at the registration desk. If you cannot use tickets you have reserved, please notify the Chairman of the Refresher Course Committee.

Read the description of the courses, noting particularly the days they are offered, and make your selection for each day. State your first, second, and third preferences, as the number attending each course will be limited by the capacity of the room. You will be notified regarding your selections.

After you have gone over these courses, the committee would appreciate any ideas you may have for future courses, as well as new instructors for courses now being given. Please make a note of your suggestions on a card and leave it at the registration desk when you pick up your tickets.

Course No. 1: 2:30–4:30 P.M., Sunday

Fundamental Problems in Therapy

MILTON FRIEDMAN, M.D., New York, N. Y.
Moderator

JUAN A. DEL REGATO, M.D., Colorado Springs, Colo.
THOMAS A. WATSON, M.D., Saskatoon, Sask.
SIMEON T. CANTRIL, M.D., Seattle, Wash.
RICHARD H. CHAMBERLAIN, M.D., Philadelphia

Ten representative lesions treated by irradiation have been selected. Diagrams, photographs, microscopic slides, and details of treatment will have been sent to members of the panel, the result of the treatment being withheld. Each member will discuss the treatments given, indicating how and why his own technic would differ. The eventual outcome of the case will then be disclosed.

The panel members have been selected as representing different schools of radiotherapy, and an attempt will be made to resolve differences in radiotherapeutic approach. Special emphasis will be placed on treatment technics and time factors.

Course No. 2: 7–9 P.M., Sunday

Film Interpretation Session

SYDNEY F. THOMAS, M.D., Palo Alto, Calif.
Moderator

BERNARD J. O'LOUGHLIN, M.D., Los Angeles, Calif.
WEBSTER H. BROWN, M.D., Baltimore, Md.
BENJAMIN FELSON, M.D., Cincinnati, Ohio

This session is a diagnostic symposium designed to illustrate basic principles of film interpretation. It is based upon proved cases which will be demonstrated at the time of the course. The material presented will be supplemented by key films displayed at the afternoon session, so that the audience will have a chance to see some of the original material.

Any member of the Radiological Society who desires to present a case which seems to merit display may submit the films, clinical summary, and pathological slides to the moderator of the Session, Dr. Sydney F. Thomas, 300 Homer Ave., Palo Alto, Calif.

Course No. 3: 8:30–10 A.M., Monday

Myelography

HAROLD O. PETERSON, M.D.
St. Paul, Minn.

Pantopaque myelography will be discussed from the standpoint of technic, normal anatomy and variations, subdural and extradural injections, cord tumors, herniated disks, and miscellaneous conditions. Details of the best and simplest method of injecting and removing the Pantopaque with essentially no discomfort to the patient will be included.

From a diagnostic standpoint, the importance of recognizing normal variations and subdural injections will be stressed.

Cord tumors and herniated disks will be discussed in as much detail as time permits.

Course No. 4: 8:30–10 A.M., Monday

Clinical Use of Radioactive Isotopes

DONALD S. CHILDS, Jr., M.D., and
ALAN L. ORVIS, M.D.
Rochester, Minn.

The diagnostic and therapeutic applications of radioactive isotopes in medical practice will be discussed.

The physical and physiologic bases of certain diagnostic tests, technics of instrumentation, and interpretation of results will be considered. Tests of thyroid function and blood dyscrasia studies will be emphasized.

The therapeutic applications to be included are I^{131} in hyperthyroid states, I^{131} in thyroid cancer, I^{131} to produce a hypothyroid state, P^{32} in polycythemia and leukemia, and the radioactive colloids.

(This course continued Tuesday, Course No. 13)

Course No. 5: 8:30–10 A.M., Monday

Treatment of Cancer of the Skin and Lip

BERNARD P. WIDMANN, M.D.
Philadelphia, Penna.

The management and treatment of cancer of the skin and lip as a radiological problem will be discussed in detail. Recognized technical procedures will be reviewed. Mathematical formulae of dosage will be advocated according to special conditions and indications for all types of lesions, both large and small. The advantages of varying the rate and intensities according to size will be analyzed. Technics of irradiation with low-voltage (80 to 100 kv) and high voltage (200 kv), as well as "contact" irradiation, will be reviewed. Reactions and complications involving the bone, cartilage, and eye, and late skin changes will be discussed. Indications for supplementary surgical measures will be submitted.

Course No. 6: 8:30–10 A.M., Monday

Basic Radiation Dosimetry

H. M. PARKER
Richland, Wash.

1. Influence of spatial and temporal distribution of ionizing events in tissue.
2. Energy absorption in tissue as the basis for dosimetry.
3. Direct measurement of energy absorption—calorimetry.
4. Indirect measurement of energy absorption—the Bragg-Gray principle.
5. Relationship of the roentgen to this principle.
6. Extension of dosimetry to particulate radiation.
7. Use of the terms "rep," "rad," and "rem."
8. Dosimetry of radioisotope distributions in tissue—the "infinite mass" simplification.
9. Simple modifications of the infinite mass case.

Course No. 7: 8:30–10 A.M., Monday

X-ray Diagnosis of Benign and Malignant Bone Neoplasms

PAUL C. HODGES, M.D., and
ROBERT D. MOSELEY, Jr. M.D.
Chicago, Ill.

Radiology can be depended upon to differentiate neoplasm from non-neoplastic skeletal lesions in most cases, and usually to distinguish between benign neoplasms and those that are malignant. Less frequently it can determine the particular type of a benign or malignant tumor. The orthopedic surgeon, radiologist, and bone pathologist have to work as an integrated team if the patient's best interests are to be served, and, as in all true teamwork, each member contributes something that is essential. It is futile to attempt to appraise the relative value of the contributions of individual team mates. The instructors have nothing new to present. They will show lantern slides of the commoner benign and malignant skeletal neoplasms and of non-malignant conditions that sometimes are misinterpreted as malignant.

(This course continued Tuesday, Course No. 16)

Course No. 8: 8:30–10 A.M., Monday

Duodenal Ulcer

ARTHUR FINKELSTEIN, M.D.
Philadelphia, Penna.

An informal review of the diagnostic criteria for duodenal ulcer. The importance of the crater, and methods of demonstrating it. Relative importance of fluoroscopy and radiography. Spot-filming and compression. Differentiation between a crater and barium caught between distorted folds. Evaluation of "secondary signs." Recognition of complications. Criteria of healing.

This will be a lantern slide demonstration, and will terminate with a question and answer period.

Course No. 9: 8:30–10 A.M., Monday

Roentgenologic Diagnosis of Diseases of the Skull

JOHN D. CAMP, M.D.
Los Angeles, Calif.

This course will relate to non-traumatic lesions of the skull. The following subjects will be considered: pseudo-lesions; congenital and developmental anomalies; inflammatory disease; tumors, benign and malignant; the changes observed in various diseases of systemic origin.

Course No. 10: 8:30–10 A.M., Monday

X-Ray Motion Picture Technics and Their Applications

GEORGE H. RAMSEY, M.D.,
CHARLES E. SHERWOOD, M.D., and
RAYMOND GRAMIAK, M.D.
Rochester, N. Y.

1. *Machinery and Technical Factors:* Cinefluorography with and without electronic screen intensification. Advantages and disadvantages of direct cineradiography. Importance of optical printing.

2. *Use in Teaching and Research:* Demonstration of film loops. Combined "still" and motion viewing for obtaining maximum information from films. Kymographic analysis of slow-motion films of the heart chambers, great vessels, etc.

3. *Contributions to Radiological Diagnosis:* Clearing up of doubtful fluoroscopic observations of esophageal and gastric peristalsis, bladder and urethral function, etc: More exact analysis of disturbances of reflex action. New cinefluorographic criteria for evaluating congenital cardiac anomalies, disorders of the cervical spine, speech defects, and dysphagias.

(*Course to be repeated—not continued—Friday, Course 46*)

Course No. 11: 8:30–10 A.M., Monday

Radiation Chemistry of Aqueous Solutions

EDWIN J. HART, M.D.
Lemont, Ill.

The general nature of the chemical reactions induced by ionizing radiations in water will be treated on the basis of current ideas regarding the distribution of free radical and stable chemical species formed in irradiated water. It will be shown how studies on the effect of dosage rate, track density, concentration of solutes, pH, and presence or absence of oxygen are used to establish the identity and properties of these intermediate chemically reactive species. Application of these results to the chemical dosimetry of alpha, beta, and gamma rays and to problems in chemistry and biology will also be discussed.

Course No. 12: 8:30–10 A.M., Tuesday

Technics of Pediatric Radiology

JOHN W. HOPE, M.D.
Philadelphia, Penna.

Most departments of radiology in general hospitals work and think predominantly in terms of adults. Children, particularly infants, are considered necessary evils, to be examined without much enthusiasm on the part of the technician and the radiologist. This course is designed to point out the fallacy of this point of view by presenting methods of obtaining diagnostic studies of these young patients. The course will be divided into two parts. The first (Tuesday) will deal with the chest, neck, genitourinary tract, and the use of air as a contrast medium in lesions of the abdomen. The second (Wednesday) will deal with the gastrointestinal tract, skull, and extremities.

(*This course continued Wednesday, Course No. 21*)

Course No. 13: 8:30–10 A.M., Tuesday

Clinical Use of Radioactive Isotopes

DONALD S. CHILDS, Jr., M.D., and
ALAN L. ORVIS, M.D.

(*Continued from Monday, Course No. 4*)

Course No. 14: 8:30–10 A.M., Tuesday

Problems and Pitfalls in X-Ray Calibration and Protection Surveys

CARL B. BRAESTRUP
New York, N. Y.

Discussion and demonstration of x-ray measurements of useful beam and stray radiation. Emphasis will be placed upon the common sources of error in calibrating x-ray equipment, including limitations of the r-meter, improper measuring procedures, and defects in equipment.

Course No. 15: 8:30–10 A.M., Tuesday

Roentgen Cardiology

MELVIN M. FIGLEY, M.D.
Ann Arbor, Mich.

This course will consider in detail examination of the heart and intrathoracic vessels by fluoroscopy and simple roentgenography. Angiocardiography will be used liberally to illustrate alterations in morphology and function. As it will be impossible to consider the roentgen aspects of every type of cardiac disease, attention will be given principally to those types of acquired and congenital heart disease of surgical importance. An attempt will be made to indicate both the potentialities and the limitations of these simple methods in cardiac diagnosis. Part I will consider methods of examination, normal anatomy, and acquired heart disease; Part II, congenital heart disease.

(*This course continued Wednesday, Course No. 24*)

Course No. 16: 8:30–10 A.M., Tuesday

X-ray Diagnosis of Benign and Malignant Bone Neoplasms

PAUL C. HODGES, M.D., and
ROBERT D. MOSELEY, Jr., M.D.

(*Continued from Monday, Course No. 7*)

Course No. 17: 8:30–10 A.M., Tuesday

X-Raying the Stomach: Special Technics

ARTHUR FINKELSTEIN, M.D.
Philadelphia, Penna.

The importance of preliminary removal of nonopaque residue; methods employed, including astringent lavage. Use of respiratory movement in differentiating extrinsic pressure from intrinsic lesions. Multiple exposures during swallowing, for detection of small or sliding hiatal hernias. Overdistention technic for demonstration of regurgitation in the study of pyrosis. Combined filling of stomach and colon in the evaluation of the splenic flexure syndrome. Various methods for producing double-contrast visualization of the fundus. Pharmacoradiology.

This will be a lantern slide demonstration, and will terminate with a question and answer period.

Course No. 18: 8:30–10 A.M., Tuesday

Roentgenologic Changes in Intracranial Disease

JOHN D. CAMP, M.D.
Los Angeles, Calif.

This course will emphasize the value of conventional roentgenograms in the diagnosis and localization of intracranial disease. In many instances, a precise localization and diagnosis of the basic lesion can be made without resorting to more complicated and elaborate roentgenologic investigations. The fundamental signs, consisting of calcification within the lesion, changes in contiguous bony structures, displacement of the pineal, and asymmetry of the calvarium, will be reviewed.

Course No. 19: 8:30–10 A.M., Tuesday

Radiation Therapy in Carcinoma of the Larynx

SIMEON T. CANTRIL, M.D.
Seattle, Wash.

The discussion will be related to the selection of patients suitable for irradiation, evaluation of therapeutic technics for laryngeal cancer of various types and extent, complications of irradiation, and results. The presentation will be amplified by case demonstrations, and discussion. Questions will be welcome.

Course No. 20: 8:30–10 A.M., Tuesday

Radiation Effects at the Cellular Level

RAYMOND E. ZIRKLE, Ph.D.
Chicago, Ill.

This course will stress recent investigations of the action of radiation on genes, chromosomes, and cell division, with special reference to modification of these actions by the following factors: (1) ion density produced by the radiations; (2) chemicals in the cell or its medium; (3) portion of cell irradiated.

The course will be illustrated by lantern slides and by time-lapse motion pictures showing various types of mitotic aberrations in irradiated cells.

Course No. 21: 8:30–10 A.M., Wednesday

Technics of Pediatric Radiology

JOHN W. HOPE, M.D.

(*Continued from Tuesday, Course No. 12*)

Course No. 22: 8:30–10 A.M., Wednesday

Diseases of the Joints

LESTER W. PAUL, M.D., and
D. MURRAY ANGEVINE, M.D.
Madison, Wisc.

This course will be a joint effort covering the pathologic (Dr. Angevine, Professor of Pathology, University of Wisconsin) and roentgenologic (Dr. Paul) aspects of disease of the joints. The pathology of joint disease will be presented from the point of view of establishing a basis for the changes seen in the roentgenogram. While the major emphasis will be on the diagnosis of the various forms of arthritis, attention will be given to other lesions involving the joints and contiguous structures. Some problem cases will be used, and the atypical manifestations of the more common diseases of the joints will be discussed.

It is planned to present the material by first illustrating the pathology of the disease and its pathogenesis, followed by a discussion of the roentgen changes. Each disease will be considered in this manner separately. Finally, the problem cases and atypical variants will be shown. In this manner it is hoped that a solid foundation for the roentgen diagnosis of joint disease can be established within the limits of our present experience and knowledge. Time will be allowed for questions and discussion from those attending the course.

(*This course continued Thursday, Course No. 31*)

Course No. 23: 8:30–10 A.M., Wednesday

Radium and Radioisotope Dosimetry

ELIZABETH F. FOCHT
New York, N. Y.

The principles and technics of dosage calculations in the use of discrete sources for intracavitary or interstitial therapy are similar for all gamma-emitting isotopes. The fundamentals of distribution, amount, exposure, filter, and dose will be discussed for gamma-ray sources in general and then for particular variations of the more commonly employed elements, such as radium, radon, cobalt, gold, etc.

In some circumstances beta radiation may make a

SUNDAY, Dec. 11 2:30–4:30 P.M.	MONDAY, Dec. 12 8:30–10 A.M.	TUESDAY, Dec. 13 8:30–10 A.M.
1. **Fundamental Problems in Therapy** Milton Friedman, M.D., Moderator Juan A. del Regato, M.D. Thomas A. Watson, M.D. Simeon T. Cantril, M.D. Richard H. Chamberlain, M.D.	3. **Myelography** Harold O. Peterson, M.D.	12. **Technics of Pediatric Radiology (continued Wednesday)** John W. Hope, M.D.
	4. **Clinical Use of Radioactive Isotopes (continued Tuesday)** Donald S. Childs, Jr., M.D. Alan L. Orvis, M.D.	13. **Clinical Use of Radioactive Isotopes (continued from Monday)** Donald S. Childs, Jr., M.D. Alan L. Orvis, M.D.
	5. **Treatment of Cancer of the Skin and Lip** Bernard P. Widmann, M.D.	14. **Problems and Pitfalls in X-ray Calibration and Protection Surveys** Carl B. Braestrup
	6. **Basic Radiation Dosimetry** H. M. Parker	15. **Roentgen Cardiology (continued Wednesday)** Melvin M. Figley, M.D.
7–9 P.M.	7. **X-ray Diagnosis of Benign and Malignant Bone Neoplasms (continued Tuesday)** Paul C. Hodges, M.D., Robert D. Moseley, Jr., M.D.	16. **X-ray Diagnosis of Benign and Malignant Bone Neoplasms (continued from Monday)** Paul C. Hodges, M.D. Robert D. Moseley, Jr., M.D.
2. **Film Interpretation Session** Sydney F. Thomas, M.D., Moderator Bernard J. O'Loughlin, M.D. Webster H. Brown, M.D. Benjamin Felson, M.D.	8. **Duodenal Ulcer** Arthur Finkelstein, M.D.	17. **X-raying the Stomach: Special Technics** Arthur Finkelstein, M.D.
	9. **Roentgenologic Diagnosis of Diseases of the Skull** John D. Camp, M.D.	18. **Roentgenologic Changes in Intracranial Disease** John D. Camp, M.D.
	10. **X-ray Motion Picture Technics and Their Applications (repeated Friday)** George H. Ramsey, M.D., Charles E. Sherwood, M.D., Raymond Gramiak, M.D.	19. **Radiation Therapy in Carcinoma of the Larynx** Simeon T. Cantril, M.D.
	11. **Radiation Chemistry of Aqueous Solutions** Edwin J. Hart, M.D.	20. **Radiation Effects at the Cellular Level** Raymond E. Zirkle, Ph.D.

WEDNESDAY, Dec. 14 8:30–10 A.M.	THURSDAY, Dec. 15 8:30–10 A.M.	FRIDAY, Dec. 16 8:30–10 A.M.
21. **Technics of Pediatric Radiology (continued from Tuesday)** John W. Hope, M.D.	30. **Carcinoma of the Cervix and Fundus Uteri** Edwin C. Ernst, M.D.	39. **What the Chief Should Teach His Young Braves About the Ethics and Economics of Radiology** W. Edward Chamberlain, M.D.
22. **Diseases of the Joints (continued Thursday)** Lester W. Paul, M.D. D. Murray Angevine, M.D.	31. **Diseases of the Joints (continued from Wednesday)** Lester W. Paul, M.D. D. Murray Angevine, M.D.	40. **High Energy Accelerators for Therapy** Lester S. Skaggs, Ph.D.
23. **Radium and Radioisotope Dosimetry** Elizabeth F. Focht	32. **Cerebral Angiography (continued Friday)** Howard L. Steinbach, M.D.	41. **Cerebral Angiography (continued from Thursday)** Howard L. Steinbach, M.D.
24. **Roentgen Cardiology (continued from Tuesday)** Melvin M. Figley, M.D.	33. **Design and Equipment of Radioisotope Laboratories** G. W. Morgan	42. **Some of the Practical Problems Encountered in the Preparation and Use of Isodose Charts** E. Dale Trout, D.Sc. John P. Kelley, B.S.
25. **Medicolegal Problems** Charles L. Ewing	34. **Some Fundamentals in Chest Roentgen Interpretation (continued Friday)** Benjamin Felson, M.D.	43. **Some Fundamentals in Chest Roentgen Interpretation (continued from Thursday)** Benjamin Felson, M.D.
26. **Diagnostic Radiology in Gynecology and Obstetrics** Fred O. Coe, M.D.	35. **The Statistical Point of View (continued Friday)** Harold Tivey, M.D.	44. **The Statistical Point of View (continued from Thursday)** Harold Tivey, M.D.
27. **Examination of the Colon** Charles W. Yates, M.D.	36. **Roentgen Examination of the Sinuses and Mastoids (continued Friday)** Barton R. Young, M.D.	45. **Roentgen Examination of the Sinuses and Mastoids (continued from Thursday)** Barton R. Young, M.D.
28. **Protective Agents Against Radiation Damage** Leon O. Jacobson, M.D.	37. **Roentgen Examination of the Small Bowel** Ross Golden, M.D.	46. **X-ray Motion Picture Technics and Their Applications (Repetition of Course No. 10)** George H. Ramsey, M.D. Charles E. Sherwood, M.D. Raymond Gramiak, M.D.
29. **Diagnostic Urology** Joseph C. Bell, M.D.	38. **Rotation Therapy** Robert Robbins, M.D. Jean Meszaros, M.S.	47. **Roentgenologic Aspects of Painful Hip Conditions in Adults** George D. Davis, M.D.

contribution, and it is necessary to evaluate the calculations in such cases.

Radiographic technics for determining spatial arrangement and gadgets for working out the dose in the case of non-rigid distributions will be reviewed. Models of some actual needle and seed distributions will be shown, and the method of making them outlined.

Course No. 24: 8:30–10 A.M., Wednesday

Roentgen Cardiology

MELVIN M. FIGLEY, M.D.
Ann Arbor, Mich.

(*Continued from Tuesday, Course No. 15*)

Course No. 25: 8:30–10 A.M., Wednesday

Medicolegal Problems

CHARLES L. EWING
General Claims Attorney,
Atchison, Topeka and Santa Fe Railroad
Topeka, Kans.

Informal discussion of the medicolegal problems confronting the radiologist.

The rights and duties of expert witnesses, including the right to demand fees before testifying.

Testimony both in court and by deposition.

Some suggestions regarding office records, clinical records, examination notes, written reports, and their impact on litigation.

Course No. 26: 8:30–10 A.M., Wednesday

Diagnostic Radiology in Gynecology and Obstetrics

FRED O. COE, M.D.
Washington, D. C.

This course is concerned with consideration of the problems of hysterosalpingography, with discussion of the various media used. A brief résumé of the technic of the procedure, the precautions, and dangers involved.

Brief discussion of a reliable method of cephalopelvimetry.

Course No. 27: 8:30–10 A.M., Wednesday

Examination of the Colon

CHARLES W. YATES, M.D.
Houston, Texas

The various types of examination of the colon will be discussed, with reference to indications, preparation, and conduct of the examination, and some of the more common pitfalls encountered. Reference will be made to the use of the double-contrast technic in children. Lantern slides will be used to demonstrate specific lesions.

Course No. 28: 8:30–10 A.M., Wednesday

Protective Agents Against Radiation Damage

LEON O. JACOBSON, M.D.
Chicago, Ill.

Data are available which conclusively show that survival of laboratory animals subjected to a single lethal dose of total-body x-irradiation can be significantly increased by measures instituted before or after the radiation injury has been sustained. Evidence is also available that the injury produced by repeated or chronic exposure to radiation can be altered favorably. The effective prophylactic measures include the administration of such materials as estrogens, cysteine, or glutathione. "Therapeutic" measures, or, more correctly, measures instituted after irradiation injury, include spleen shielding, intraperitoneal implantation of splenic tissue, intraperitoneal implantation of embryo suspensions, intravenous or intraperitoneal injection of homologous bone-marrow suspensions, and related technics. Recent evidence indicates that heterologous tissue (splenic or bone marrow) is also effective. Although the mechanisms of action of these "prophylactic" and "therapeutic" measures are not known, the evidence at hand tends to indicate that they are different and possibly unrelated.

These data tend to support the hypothesis that cells of the shielded tissue, tissue transplant, or injected cell preparations produce a substance or group of substances essential to the recovery of cells and cellular systems inhibited by irradiation.

Course No. 29: 8:30–10 A.M., Wednesday

Diagnostic Urology

JOSEPH C. BELL, M.D.
Louisville, Ky.

Basic principles, methods of examination, and findings in various urologic conditions will be considered and illustrated by lantern slides. Intravenous urography will be given special consideration. The various media commonly employed in this country will be discussed, especially from the standpoint of indications and contraindications. Possible reactions will be considered.

The relative importance of retrograde and excretory urography from the diagnostic standpoint will be discussed.

Course No. 30: 8:30–10 A.M., Thursday

Carcinoma of the Cervix and Fundus Uteri

EDWIN C. ERNST, M.D.
St. Louis, Mo.

1. The more recently improved radiation technics will be clinically and statistically compared with the more or less empirical procedures formerly em-

REFRESHER COURSES

THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

December 11 through December 16, 1955

PALMER HOUSE

CHICAGO, ILLINOIS

(Detach here) SEE INSTRUCTIONS ON REVERSE SIDE

FILL OUT THE FOLLOWING

(Print or type).....M.D.
Last Name First Name or Initials

.....
Street Address

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City State

CHECK THE FOLLOWING

Member R.S.N.A. ☐ Guest ☐

Resident or fellow in Radiology at present ☐ Where.....

Medical Student ☐ Where.....

Reserve Officer on Active Duty at present ☐ Trainee in Physics ☐

Fill out, also, the enrollment diagram on the reverse side of this page

INSTRUCTIONS FOR ENROLLMENT IN

REFRESHER COURSES

Read the accompanying description of the courses and plan of presentation. Register early; the number admitted to each course will be limited by the seating capacity of the rooms. Reservations will be made in the order of the receipt of request.

Courses are limited to the medical profession, including graduate students and residents in radiology; radiation physicists, radiobiologists, chemists, and others closely concerned with the science of radiology; and medical students certified by the deans of their respective colleges.

All tickets will be held for you at the R.S.N.A. Registration Desk in the Palmer House.

The registration fee, where applicable, will cover the cost of the Refresher Courses. Members, guest speakers, guest instructors, scientific exhibitors, residents or fellows in radiology, medical students, members of the Armed Forces, and trainees in physics do not pay a registration fee. Non-members not in these groups will pay, *at the time of registration*, a fee of $15.00, which will include the Refresher Courses.

PLEASE INDICATE YOUR FIRST, SECOND AND THIRD CHOICES

Tickets Will Be Picked Up at Time of Registration

	First Choice		Second Choice		Third Choice	
	Course No.	Instructor	Course No.	Instructor	Course No.	Instructor
Sunday, Dec. 11 2:30 P.M.						
7 P.M.						
Monday, Dec. 12						
Tuesday, Dec. 13						
Wednesday, Dec. 14						
Thursday, Dec. 15						
Friday, Dec. 16						

Mail this order sheet to Robert D. Moreton, M.D., Chairman, Refresher Course Committee
Prior to Dec. 1, 1217 W. Cannon, Fort Worth, Texas.
After Dec. 1, c/o Radiological Society of North America, Palmer House, Chicago.

Do Not Send Money With This Application!

ployed in the instructor's clinic for the treatment of cancer of the cervix.

2. Moving pictures will be shown of the actual clinical application of radium with a single-unit expanding type of applicator for different types and stages of uterine cancers.

3. Recent progress made in the establishment of radium dosage factors throughout 150 areas in the pelvis, additional advances in the more reliable and accurate fixation of the radium capsules in the vaginal vault, and plans for coordinating and timing of the various radiation therapy procedures will be discussed, evaluated and illustrated by means of lantern slides.

4. General discussion of the technical features of the Paris, Stockholm, Manchester, sponge-rubber, radium needle, and other methods.

5. External and transvaginal roentgen therapy.

6. Question period and final discussion.

Course No. 31: 8:30–10 A.M., Thursday

Diseases of the Joints

LESTER W. PAUL, M.D., and
D. MURRAY ANGEVINE, M.D.

(*Continued from Wednesday, Course No. 22*)

Course No. 32: 8:30–10 A.M., Thursday

Cerebral Angiography

HOWARD L. STEINBACH, M.D.
San Francisco, Calif.

A brief summary of the technics of cerebral angiography will be presented. The opaque media and the undesirable side-reactions will be reviewed. The methods of injection and types of anesthesia will also be discussed.

The second part of the course will take up the indications for cerebral angiography in comparison with pneumography, the normal anatomy of the arteries and veins, and variations of the cerebral vessels. Abnormal cerebral angiograms will then be discussed, including vascular lesions, space-consuming lesions, and cerebral anomalies.

The course will be well illustrated with radiographs, and a mimeographed outline will be furnished to participants.

(*This course continued Friday, Course No. 41*)

Course No. 33: 8:30–10 A.M., Thursday

Design and Equipment of Radioisotope Laboratories

G. W. MORGAN
AEC Isotopes Division, Oak Ridge, Tenn.

Practical aspects of the design of and equipment for hospital radioisotope laboratories will be discussed, with suggested facilities for different programs utilizing different radioisotopes. Prototype laboratories and facilities will be presented for diagnostic and therapeutic programs (including those in which the radioisotopes are purchased in a form standardized ready for use), as well as for programs involving animal experimentation. Scale models of typical laboratories will be displayed.

Course No. 34: 8:30–10 A.M., Thursday

Some Fundamentals in Chest Roentgen Interpretation

BENJAMIN FELSON, M.D.
Cincinnati, Ohio

Chest roentgen interpretation should not merely represent an attempt to correlate particular shadows with specific diseases, but should be approached with an understanding of the basic principles of anatomy, physiology, pathology, and radiology involved. Some of these principles will be considered and their practical application illustrated.

Among the subjects to be discussed are:

First Session

1. A method of fluoroscopy.
2. Dionosil bronchography.
3. The "silhouette" sign.
4. The air bronchogram.

Second Session

1. Anatomic variations in the pulmonary fissures.
2. Lobar collapse.
3. Lobar enlargement.
4. The disrupted fissure.

(*This course continued Friday, Course No. 43*)

Course No. 35: 8:30–10 A.M., Thursday

The Statistical Point of View

(How to look a statistic in the face with equanimity)

HAROLD TIVEY, M.D.
Houston, Texas

The purpose of this course is to review, in a nonmathematical fashion, those statistical methods useful to the practicing radiologist both in the evaluation of his own results and in the equally critical examination of the published work of others.

A brief appraisal of some current methods of presentation of data will be given, with particular emphasis on the basic concepts, the implications of such methods, and the logical pitfalls which may be encountered by both the investigator and his readers. The intent is to enable us to face the ordinary statistics with adequate equanimity and deserved skepticism.

The general problem of evaluation of survival time data in patients with malignant tumors will be discussed. There are now available methods by which the proportion of patients cured and the times of death of those patients not cured may be predicted long in advance of the ultimate outcome of the series. Such predictions appear to be reliable within the confidence limits which can be placed upon the results

of the usual series of 100 patients if the analysis is made as early as the time required for the first half of the patients in the series to die. (For many tumors, this interval will be less than three years after the last patient of the series is treated.) These methods will be presented by means of appropriate examples.

Mimeographed notes will be furnished those who wish to explore such problems in greater detail.

(*This course continued on Friday, Course No. 44*)

Course No. 36: 8:30–10 A.M., Thursday

Roentgen Examination of the Sinuses and Mastoids

BARTON R. YOUNG, M.D.
Philadelphia, Penna.

The course will be given in two sessions. Discussions will be limited to the sinuses in the first period and to the mastoids in the second session. Technic of examination will be considered initially, and then normal and abnormal development from birth to maturity will be discussed and illustrated.

Roentgen findings in infections and tumors and complications of chronic infections in the sinuses and mastoids, including mucoperiostitis, osteomyelitis, cholesteatoma, otogenic meningitis, and brain abscess, will be demonstrated. Several other interesting abnormalities will be included.

(*This course continued Friday, Course No. 45*)

Course No. 37: 8:30–10 A.M., Thursday

Roentgen Examination of the Small Bowel

ROSS GOLDEN, M.D.
Los Angeles, Calif.

Effect of resection on function.
Symptoms of disorders and diseases.
Review of anatomy.
Neurophysiology.
Some functional disorders and their physiologic background.
Effect of certain drugs.
Gas distention of functional and organic origin.
Amyloidosis.
Symptoms and physical effects of organic disease in 168 cases.
Neoplasms of the small intestine; analysis of 74 cases.
Sources of error.

Course No. 38: 8:30–10 A.M., Thursday

Rotation Therapy

ROBERT ROBBINS, M.D., and
JEAN MESZAROS, M.S.
Philadelphia, Penna.

Terminology and types of rotation therapy; dose distributions for various types of rotation, and modification of dose patterns by partial rotation, weighting, shifting of axis or variation of body contour.

2. Comparison with conventional and supervoltage fixed portal therapy, with respect to dose pattern, convenience, reproducibility, set-up time.
3. Importance of localization and set-up technics, fluoroscopy, radiographic check, light beam pointers, transit dose, other devices.
4. Methods of dosimetry.
   (*a*) Published results for specific examples.
   (*b*) "Simulated beam" calculation.
   (*c*) "Isodose curve" calculation.
   (*d*) Transit-dose measurement.
   (*e*) Computers.
   (*f*) Measurements in phantom.

Course No. 39: 8:30–10 A.M., Friday

What the Chief Should Teach His Young Braves About the Ethics and Economics of Radiology

W. EDWARD CHAMBERLAIN, M.D.
Philadelphia, Penna.

Relationship of the Radiologist to His Patient: In private office practice; in a hospital department of radiology; factors that may affect such relationship (for example, the effect of having the radiologist's fee collected by the hospital).

Hospital-Radiologist Relationships: In respect to departmental administration (equation number one, "responsibility minus authority equals frustration"); in respect to the method by which the radiologist is compensated; why it is best for the radiologist to collect his own fees. Selected examples of what happens to the hospital radiologist under certain conditions. Exhibit of "impossible," bad, fair, good, and exceptionally good forms of contract, or working agreement, with examples. Exhibit of good and not-so-good bookkeeping methods.

Satisfactory hospital-radiologist relationships tend to bring top-notch radiologists into hospital practice; unsatisfactory arrangements tend to drive top-notch radiologists into private office practice, thus depriving hospital in-patients of their right to the best in medical care. Where unsatisfactory hospital-radiologist relationships exist, how much of the fault lies with the radiologist and how much with the hospital? How shall we answer the charge that "the hospital radiologist has a monopoly?"

How can the young radiologist establish himself in hospital practice on a fair and equitable basis? The advantages of being employed at the time one is negotiating with hospital management. The young man should stay in an "associateship" until he has developed the requisite stature and reputation to enable him to stand up to the hospital authorities with whom he is negotiating. All too frequently the error is made of accepting an unsatisfactory arrange-

ment in the expectation of re-negotiation "in another year." Experience proves that the radiologist's only chance to get a proper contract is when he first starts.

The impact upon radiology of Blue Cross hospitalization insurance plans, the nefarious "all-inclusive, flat-rate" method of hospital billing, etc.

Course No. 40: 8:30–10 A.M., Friday

High Energy Accelerators for Therapy

L. S. SKAGGS, Ph.D.
Chicago, Ill.

High-energy accelerators (cyclotrons, betatrons, synchrotrons, linear accelerators, etc.) and nuclear reactors will be considered from the standpoint of their applicability to cancer therapy. A brief description of the machines and their operating characteristics will be given. Advantages and disadvantages will be discussed.

Course No. 41: 8:30–10 A.M., Friday

Cerebral Angiography

HOWARD L. STEINBACH, M.D.
San Francisco, Calif.

(*Continued from Thursday, Course No. 32*)

Course No. 42: 8:30–10 A.M., Friday

Some of the Practical Problems Encountered in Preparation and Use of Isodose Charts

E. DALE TROUT, Sc.D., and
JOHN P. KELLEY, B.S.
Milwaukee, Wisc.

A number of questions have been asked by users of isodose charts. In general, these are of a nature having most interest for the general radiologist who does not have access to extensive experimental facilities. The questions most often asked have been investigated and the results put into form for presentation. Slides have been made, and these have also been put into booklet form for those attending.

Course No. 43: 8:30–10 A.M., Friday

Some Fundamentals in Chest Roentgen Interpretation

BENJAMIN FELSON, M.D.
Cincinnati, Ohio

(*Continued from Thursday, Course No. 34*)

Course No. 44: 8:30–10 A.M., Friday

The Statistical Point of View

HAROLD TIVEY, M.D.
Houston, Texas

(*Continued from Thursday, Course No. 35*)

Course No. 45: 8:30–10 A.M., Friday

Roentgen Examination of the Sinuses and Mastoids

BARTON R. YOUNG, M.D.
Philadelphia, Penna.

(*Continued from Thursday, Course No. 36*)

Course No. 46: 8:30–10 A.M., Friday

X-Ray Motion Picture Technics and Their Applications

GEORGE H. RAMSEY, M.D.,
CHARLES E. SHERWOOD, M.D., and
RAYMOND GRAMIAK, M.D.

(*Repetition of Course No. 10*)

Course No. 47: 8:30–10 A.M., Friday

Roentgenologic Aspects of Painful Hip Conditions in Adults

GEORGE D. DAVIS, M.D.
Rochester, Minn.

Because of advances in remedial surgery, increasing attention is given by orthopedists to painful afflictions in and about the hip joints in adults. Hence it is pertinent for the roentgenologist to refresh his knowledge of the basic causes of such complaints and their distinguishing roentgenologic features, and to review the principal surgical reconstructive procedures that he is likely to see and have to evaluate.

Consideration will be given to roentgenologic differentiation of congenital and developmental affections and their late sequelae, the arthritides, tumors, trauma, and degenerative changes.

ARKANSAS RADIOLOGICAL SOCIETY

At its annual breakfast meeting on May 30 at the Arlington Hotel, Hot Springs, the Arkansas Radiological Society re-elected the following officers: President, Dr. George Burton of El Dorado; Vice-President, Dr. Edwin F. Gray of Little Rock; Secretary-Treasurer, Dr. Joe A. Norton, Donaghey Building, Little Rock. Dr. Joe Scruggs of Little Rock was elected to the Executive Council.

ATLANTA RADIOLOGICAL SOCIETY

Recently elected to office in the Atlanta (Georgia) Radiological Society are H. Stephen Weens, M.D., President; Ernest G. Smith, Jr., M.D., Vice-President; Charles M. Silverstein, M.D., 3254 Peachtree Road, N.E., Atlanta, Secretary-Treasurer.

BROOKLYN RADIOLOGICAL SOCIETY

At a recent meeting of the Brooklyn Radiological Society the following were elected to office: President, Dr. A. L. L. Bell; Vice-President, Dr. Daniel Butera; Secretary-Treasurer, Dr. Theodore Kamholtz, 152 Clinton St., Brooklyn.

RADIOLOGICAL SOCIETY OF GREATER CINCINNATI

The following officers were recently elected to serve the Radiological Society of Greater Cincinnati for the year 1955–56: William R. Dickens, M.D., President; Benjamin Schneider, M.D., Vice-President; Richard J. Neubauer, M.D., 831 Carew Tower, Cincinnati 2, Secretary-Treasurer.

RADIOLOGICAL SOCIETY OF HAWAII

At the June meeting of the Radiological Society of Hawaii the following were elected to office: Dr. Phillip S. Arthur, President; Dr. Hong Chong Chang, Vice-President; Dr. George W. Henry, 1133 Punchbowl, Honolulu, T. H., Secretary-Treasurer.

MAINE RADIOLOGICAL SOCIETY

At a recent meeting of the Maine Radiological Society, Dr. G. E. Clifford Logan, of Portland, was elected President; Dr. Hugh A. Smith, of Bangor, Vice-President; Dr. Walter A. Russell, Augusta General Hospital, Augusta, Secretary-Treasurer; Dr. Jack Spencer, M.D., of Portland, Councilor to the American College of Radiology.

NEW YORK ROENTGEN SOCIETY

New officers of the New York Roentgen Society are: President, Dr. Jacob Freid; Vice-President, Dr. Sidney Rubenfeld; Treasurer, Dr. John A. Evans; Secretary, Dr. Maxwell H. Poppel, 550 First Ave., New York 16.

OHIO STATE RADIOLOGICAL SOCIETY

At the annual meeting of the Ohio State Radiological Society the following officers were elected for the ensuing year: President, George R. Krause, M.D., Cleveland; Vice-President and President-Elect, Donald English, M.D., Lima; Treasurer, Paul Jones, M.D., Zanesville; Secretary, John R. Hannan, M.D., 10515 Carnegie Ave., Cleveland 6.

The next annual meeting of the Society will be held at the Deshler-Hilton Hotel, Columbus, May 12–13, 1956.

PENNSYLVANIA RADIOLOGICAL SOCIETY

The Pennsylvania Radiological Society, at its annual meeting held in Reading on May 21, elected the following officers for the year 1955–56: President, William T. Rice, M.D., Rochester; President-Elect, James M. Converse, M.D., Williamsport; First Vice-President, Jesse T. Littleton, III, M.D., Sayre; Second Vice-President, John F. Maurer, M.D., Greensburg; Editor, Carl B. Lechner, M.D., Erie; Secretary-Treasurer, Walter P. Bitner, M.D., 234 State St., Harrisburg.

AMERICAN NUCLEAR SOCIETY

The officers of the recently organized American Nuclear Society are: President, W. H. Zinn; Vice-President, Philip Sporn; Treasurer, Karl Cohen; Editor, J. G. Beckerley; Executive Secretary (Interim), Dr. William M. Breazeale, 211A Main Engineering Building, University Park, Penna. The Society meets annually in June.

DR. MERRILL C. SOSMAN HONORED

Well deserved tribute was paid to a distinguished radiologist and teacher on July 26, when a portrait of Dr. Merrill C. Sosman was unveiled in the main amphitheater of Peter Bent Brigham Hospital, Boston, Mass., with which he has been associated for many years. The portrait, the work of the artist Alfred Jonniaux, was presented to the hospital by co-workers, friends, and students of Dr. Sosman.

CONTINUATION COURSE IN RADIOLOGY UNIVERSITY OF MINNESOTA

The University of Minnesota will present its annual continuation course for radiologists at the Center for Continuation Study, November 7 to 12, 1955. The subject of this year's program will be neuroradiology.

Guest faculty will include Dr. Donald L. McRae, Chief of Radiology, Montreal Neurological Institute, McGill University Faculty of Medicine, Montreal; Dr. Ernest H. Wood, Jr., Professor of Radiology, University of North Carolina School of Medicine, Chapel Hill; Professor Erik Lindgren, Professor of Radiology, Serafimerlasarettet, Stockholm, Sweden.

The program will be presented under the direction of Dr. Leo G. Rigler, Professor and Head of the Department of Radiology, and Dr. H. O. Peterson, Clinical Professor, Department of Radiology, University of Minnesota Medical School.

Lodging and meal accommodations are available at the Center for Continuation Study.

RADIOLOGICAL PHYSICS COURSES UNIVERSITY OF CHICAGO

The University of Chicago has approved two new courses leading to the M.S. degree in Radiological Physics and in Health Physics. Both degrees are awarded by the Department of Radiology, and students will be accepted in the Fall Quarter of 1955. These courses are designed to furnish such academic background and practical understanding of the problems encountered as will enable the graduate to take his place immediately in these rapidly growing fields. Students entering these courses should have completed the equivalent of the University of Chicago B.S. degree in Physics, but must, in any case, complete all of those requirements for the Master's degree. Two years' residence is required because of the broad scope of the academic program, the second year of which is divided between academic work and service in the department at a nominal rate of pay.

Additional information may be obtained by addressing Lester S. Skaggs, Department of Radiology, The University of Chicago, 950 East 59th Street, Chicago 37, Ill.

MEDICAL RESEARCH FELLOWSHIPS

The Division of Medical Sciences of the National Academy of Sciences-National Research Council is accepting applications for post-doctoral research fellowships for 1956–57. These awards are designed to offer research experience to workers of promise who look forward to investigative careers, and not to provide practical experience in the clinical field.

Fellowships in Cancer Research are awarded by the American Cancer Society on recommendation of the Committee on Growth of the Division of Medical Sciences. Awards are available for study in all branches of the biological, chemical and physical sciences and of clinical investigation applicable to the study of growth, typical or malignant. Citizens of the United States are eligible.

British-American Exchange Fellowships in Cancer Research also are awarded by the American Cancer Society upon recommendation by the Committee on Growth.

Fellowships in Radiological Research are administered for the James Picker Foundation by the Division's Committee on Radiology. Applications will be entertained from candidates seeking to gain research skills leading to investigative careers in the field of radiology. Appointments are not limited to citizens of the United States.

Fellowships are also offered in the medical sciences and in tuberculosis.

Applications for 1956–57 under any of these programs must be postmarked on or before Dec. 1,1955. Fellowships are awarded in the early Spring. Complete details and application blanks may be obtained from the Fellowship Office, National Academy of Sciences-National Research Council, 2101 Constitution Avenue, N. W., Washington 25, D. C.

AWARDS IN RADIOLOGICAL RESEARCH JAMES PICKER FOUNDATION

On behalf of the James Picker Foundation, the National Academy of Sciences-National Research Council announces the continued availability of funds in support of radiological research. The interests of the Foundation are oriented toward, but not necessarily limited to, the diagnostic aspects of radiology. Awards are not restricted to citizens of the United States. Applications for the fiscal year 1956–57 must be submitted on or before Dec. 1, 1955.

Grants-in-aid are designed to encourage research offering promise of improvement in radiological methods of diagnosis or treatment of disease.

Grants for Scholars are a transitional form of support, designed to bridge the gap between the completion of fellowship training and the period when the young scientist has thoroughly demonstrated his competence as an independent investigator. A grant of $6,000 per year will be made directly to the Scholar's institution as a contribution toward his support, or his research, or both. Initial grants are limited to one year, but renewal may be recommended. Applications should be submitted by the institution on behalf of the candidate.

Fellowships in Radiological Research, available under the program of the Foundation, are announced under the heading Medical Research Fellowships, above.

Further details and application blanks may be obtained from the Division of Medical Sciences, National Academy of Sciences-National Research Council, 2101 Constitution Ave., N. W., Washington 25, D. C.

Books Received

Books received are acknowledged under this heading and such notice may be regarded as recognition

of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

ATLAS OF ROENTGEN ANATOMY OF THE SKULL. By LEWIS E. ETTER, B.S., F.A.C.R. Assistant Professor of Radiology, School of Medicine, University of Pittsburgh; Roentgenologist, Western Psychiatric Institute and Clinics, With a Section on The Radiographic Anatomy of the Temporal Bone by J. BROWN FARRIOR, M.D., F.A.C.S., Farrior Clinic, Tampa, Florida, and a Section on The Roentgen Anatomy of the Skull in the Newborn Infant by SAMUEL G. HENDERSON, M.D., F.A.C.R., Associate Professor of Radiology, and LOUISE S. SHERMAN, B.S., M.D., Instructor in Radiology, School of Medicine, University of Pittsburgh. A volume of 216 pages, with 239 illustrations and 7 tables. Published by Charles C Thomas, Springfield, Ill., 1955. Price $14.75.

PELVO-SPONDYLITIS OSSIFICANS. RHEUMATOID OR ANKYLOSING SPONDYLITIS. A ROENTGENOLOGICAL AND CLINICAL GUIDE TO ITS EARLY DIAGNOSIS (ESPECIALLY ANTERIOR SPONDYLITIS). By RAGNAR ROMANUS AND SVEN YDÉN, Karolinska Sjukhuset and King Gustaf V's Research Institute, Stockholm, Sweden. English translation by Joan Whitehouse. A volume of 162 pages, with 55 figures, including roentgenograms and schematic drawings. Published by The Year Book Publishers, Inc., Chicago, Ill., 1955. Price $8.50.

DIE OCCIPITO-CERVICAL-GEGEND. EINE DIAGNOSTISCH-PATHOGENETISCHE STUDIE. Fortschr. a.d. Geb. d. Röntgenstrahlen. Ergänzungsband 74. By PRIV.-DOZ. DR. J. E. W. BROCHER, Genf. A volume of 146 pages, with 185 illustrations. Published by Georg Thieme Verlag, Stuttgart, 1955. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York, N. Y. Price DM 48.— ($11.40).

LA PNEUMOSTRATIGRAPHIE. By P. BÉTOULIÉRES AND H. LATOUR, Professeurs agrégés à la Faculté de Médecine de Montpellier, with the collaboration of R. PALEIRAC and M. PÉLISSIER, Chefs de Laboratoire de Radiologie. Preface by Professeurs G. Giraud and P. Lamarque. A volume of 166 pages, with 86 figures. Published by Masson & Cie, Éditeurs, Paris, 1955.

SPLÉNO-PORTOGRAPHIE. ÉTUDE RADIOLOGIQUE ET CLINIQUE DE LA CIRCULATION PORTALE NORMALE ET PATHOLOGIQUE. EXPLORATION DES ORGANES SUS-MÉSOCOLIQUES. By LUCIEN LEGER. With a Foreword by Professeur Henri Mondor. A volume of 166 pages, with 82 figures. Published by Masson et Cie, Éditeurs, Paris, 1955. Price 1.600 fr.

X-RAY CRYSTALLOGRAPHIC STUDIES ON APATITES AND CALCIFIED STRUCTURES. Acta Radiologica Supplement 121. By DIEGO CARLSTRÖM. From the Department for Physical Cell Research, Karolinska Institutet, Stockholm. A monograph of 60 pages, with 5 figures and 2 plates. Published by Acta Radiologica, Stockholm, Sweden, 1955. Price Sw. Kr. 25:—

ARTERIOGRAPHY OF THE UTERINE ARTERY: ITS VALUE IN THE DIAGNOSIS OF UTERINE FIBROMYOMA, TUBAL PREGNANCY, ADNEXAL TUMOUR, AND PLACENTAL SITE LOCALIZATION IN CASES OF INTRA-UTERINE PREGNANCY. Acta Radiologica Supplement 122. By INGMAR FERNSTRÖM. From the Department of Diagnostic Roentgenology (Professor Knut Lindblom) and the Department of Women's Diseases (Professor Axel Westman), Karolinska Sjukhuset, Stockholm. A monograph of 128 pages, with 63 figures. Published by Acta Radiologica, Stockholm, Sweden, 1955. Price Sw. Kr. 30:—

ROENTGENOGRAPHIC DIAGNOSIS OF GENITAL TUBERCULOSIS IN THE FEMALE AND ROENTGENOGRAPHIC EFFECTS OF ANTIBIOTIC THERAPY. Acta Radiologica Supplement 123. By KRISTINA EKENGREN. From the Department of Diagnostic Roentgenology (Professor Knut Lindblom) and the Department of Women's Diseases (Professor Axel Westman), Karolinska Sjukhuset, Stockholm. A monograph of 92 pages, with 45 figures. Published by Acta Radiologica, Stockholm, Sweden, 1955. Price Sw. Kr. 30:—

THE SO-CALLED SHELF TUMOUR OF THE RECTUM. Acta Radiologica Supplement 124. By K. A. HULTBORN, O. MORALES, AND R. ROMANUS. From Radiumhemmet (Director: Professor Sven Hultberg), The Roentgen Diagnostic Department (Director: Professor Knut Lindblom), and the Department of Surgery (Director: Professor John Hellström), Karolinska Sjukhuset, Stockholm. A monograph of 46 pages, with 11 figures. Published by Acta Radiologica, Stockholm, Sweden, 1955. Price Sw. Kr. 20:—

ROENTGEN ABSORPTION SPECTROPHOTOMETRY IN QUANTITATIVE CYTOCHEMISTRY. Acta Radiologica Supplement 125. By BO LINDSTRÖM. From the Institute for Cell Research, Medical Nobel Institute, Karolinska Institutet, Stockholm. A monograph of 206 pages, with 81 figures. Published by Acta Radiologica, Stockholm, Sweden, 1955. Price Sw. Kr. 30:—

STUDIES ON RADIOIODINE TREATMENT OF THYROTOXICOSIS, WITH SPECIAL REFERENCE TO THE BEHAVIOR OF THE RADIOIODINE TRACER TESTS. Acta Radiologica Supplement 126. By LARS-GUNNAR LARSSON. From Radiumhemmet (Director: Professor Sven Hultberg), Karolinska Sjukhuset, Stockholm. A monograph of 164 pages, with 63 figures. Published by Acta Radiologica, Stockholm, Sweden, 1955. Price Sw. Kr. 25:—

Book Reviews

THE JOINTS OF THE EXTREMITIES. A RADIOGRAPHIC STUDY. NOTES ON NON-ROUTINE METHODS, NON-ROUTINE IDEAS, AND LESS-COMMON PATHOLOGY. By RAYMOND W. LEWIS, M.D., Formerly Director, Department of Radiology, Consultant in Roentgenology, The Hospital for Special Surgery, New York, N. Y. A volume of 108 pages, with 102 illustrations. Published by Charles C Thomas, Springfield, Ill., 1955. Price $8.50

In this monograph on *The Joints of the Extremities*, the author presents in an interesting and informative manner certain observations regarding technic and diagnosis which he has developed during many years of service in an orthopedic hospital. He does not attempt a complete presentation but rather emphasizes points which are not stressed in the usual texts.

The author's insistence upon the demonstration and study of the soft tissues as well as the bone and joint structures is strongly commended. His studies of the knee are especially well done. Most of the common and many of the unusual pathological conditions involving the peripheral joints are described.

The text is clearly written and contains much valuable information. Descriptions of important projections are illustrated with line drawings and radiographs, which are well selected and clearly printed. This volume should be of considerable interest to radiologists, orthopedists, and students of arthritis.

RADIOBIOLOGY SYMPOSIUM. Proceedings of the Symposium held at Liége, August-September, 1954. Edited by Z. M. BACQ, Professeur a l'Université de Liége; Membre Correspondant de l'Académie Royale de Médecine de Belgique, and PETER ALEXANDER, Chester Beatty Research Institute, Institute of Cancer Research, Royal Cancer Hospital, London. A volume of 362 pages, with numerous illustrations including graphs and tables. Published by Academic Press Inc., N. Y., and Butterworths Scientific Publications, London, 1955. Price $9.80

Scientists from twelve countries—physicists, chemists, biochemists, physiologists, cytologists, and radiotherapists—met in Liége, Belgium, in 1954 for a discussion of problems in radiobiology from the point of view of their respective specialties, in order that each might acquire knowledge of other aspects and that work in the different fields might be correlated. The papers presented have now been assembled and published under Belgian and English editorship. The book is bi-lingual, thirteen of the papers being in French, the remaining thirty-seven in English.

Chemical changes brought about by radiation, protection from radiation effects by means of chemicals or shielding, chemical radiosensitizers, and relative biological effectiveness of various ionizing radiations are among the topics discussed. Studies on micro-organisms, animals, and man are included. Most of the papers present new experimental work.

The book should be of interest to research workers in the fields of radiobiology, to radiation physicists, and to radiotherapists.

LES CANCERS DU COLON. By MARCEL ROUX, Professeur agrégé à la Faculté de Médecine de Paris, Chirurgien des Hôpitaux, and F. CARCASSONNE, Professeur à la Faculté de Médecine de Marseille; with the collaboration of R. LE CANUET, Chef de Laboratoire à la Faculté de Médecine de Paris, Radiologiste de l'Hôpital de l'Institut Pasteur de Paris. Preface by Professeur J. Sénèque. A book of 368 pages, with 140 illustrations. Published by Masson et Cie, Éditeurs, Paris, 1955. Price 2,600 fr. (cloth bound 3,200 fr.).

This rather extensive monograph on cancer of the colon is divided into two major parts. The first presents anatomic, pathologic, clinical, and radiologic data essential to the understanding of the nature of the disease and its diagnosis, while the second part consists essentially of a discussion of the surgical therapy and prognosis.

The most important radiologic examination is the opaque enema study in the properly prepared patient. Discovery of an organic lesion must be followed by its correct interpretation. The involved area of rigidity or intrinsic tumor formation must be constant on successive films of the same examination as well as in successive examinations. Artefacts such as fecal material, functional hypertonicity, and extrinsic compression caused by such lesions as mucocele of the appendix, enlarged lymph nodes, and other masses may be confusing.

There are four important signs to consider in the radiologic diagnosis of cancer of the colon. First, the image created by the tumor; second, the pattern at the junction with the adjacent normal colon (invagination, shelf formation, overhanging edges); third, modifications in the colonic wall directly involved; fourth, modifications created by the tumor in neighboring organs, including the actions of compression and of fistulization. These are discussed in detail, followed by essential diagnostic features encountered in lesions in various portions of the colon.

A detailed discussion of surgical therapy, including preoperative and postoperative care, as well as various operative procedures, is presented. Prognosis is considered thoroughly.

This monograph will be useful for a reference to any physician or surgeon who reads French and who is interested in the nature, diagnosis, and treatment of colonic cancer.

DAS TRANSVERSALE SCHICHTVERFAHREN. Fortschr. a. d. Geb. d. Röntgenstrahlen Ergänzungsband 71. By Doz. DR. MED. ALFRED GEBAUER, Frankfurt a. M. and DR. MED. ALFRED SCHANEN, Bremen. Mit einer technischen Einführung von Doz. Dr. F. Wachsmann, Erlangen. A volume of 314 pages, with 469 illustrations. Published by Georg Thieme Verlag, Stuttgart, 1955. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York, N.Y. Price DM 97.50.—($23.20).

On the basis of seven years of experience, the authors report the development, technical aspects, anatomo-topographic considerations, indications for, and clinical application of transverse layer radiography (tomography). They have divided their work into two parts: general, comprising 41 pages, and special, developed in 267 pages.

Part I is subdivided into two sections, the first of which deals with the physical and technical details of transverse tomography and describes different types of equipment and their practical application. The second section, in the form of an anatomical atlas, presents eleven normal transverse anatomical sections of the thorax for comparison with corresponding layers obtained by transverse tomography.

Part II comprises an extensive account of the clinical use of transverse tomography in various areas, as the thorax, abdomen, and skeletal system. The material is presented in atlas form with pertinent brief histories, clinical observations, and radiographic findings. The following diseases of the thorax are described: inflammatory processes about the mediastinum; tuberculosis and non-specific lesions such as abscesses, bronchiectasis, and cysts; silicosis; diseases of the heart and great vessels. The localization of foreign bodies is also included. Normal transverse sections of the abdomen with and without pneumoperitoneum are shown, and two pathological cases are reported. The skull and spine are also described and illustrated by means of normal anatomical sections and tomographic sections.

Transverse tomography is considered an important aid in radiation therapy and four cases are presented in which isodose curves and depth dose measurements were obtained by utilizing the procedure.

In the final chapter, the authors summarize their experience and discuss in a comprehensive manner the indications for this type of examination and its third-dimensional value. It is especially advantageous in parts where other methods fail to a considerable extent, as the hilar regions, the anterior mediastinum, Holzknecht's space, and apices of the lungs, where the upper ribs are in the way of conventional tomograms. Transverse tomography permits an exact preoperative evaluation of the size, shape and location of tumors, abscesses, cavities, plombage, empyema, foreign bodies, lymph node masses; it is especially useful when a kyphoscoliotic thorax is examined. It can also be applied in examinations of the heart, great vessels, and possibly of the thyroid, and is indicated in examination of the abdomen for masses, in conjunction with pneumoperitoneum. It can be used to advantage in examinations of the spine, extremities, sinuses, middle ear, and orbits and may be combined with encephalography. It is conceivable that it can be applied when hollow organs filled with opaque medium are to be investigated. The method should prove to be of considerable help in the exact determination of depth doses for deep-seated tumors and in planning the method of treatment. It might also be of help in didactic instruction of students by localizing a disease process and thereby permitting a correlation of auscultation and percussion with roentgen findings.

The monograph is well written and has excellent illustrations. Each chapter is followed by an extensive bibliography and there is a general name and subject index. Transverse tomography is a relatively new development and no adequate literature on this subject is available in the United States. This volume can be highly recommended, as it fills a gap in our present-day literature.

BRONCHUS UND TUBERKULOSE. BRONCHOSKOPISCHE UND BRONCHOGRAPHISCHE UNTERSUCHUNGEN DER BRONCHEN BEI DER TUBERKULOSE. Fortschr. a. d. Geb. d. Röntgenstrahlen Ergänzungsband 73. By DR. MED. A. HUZLY, Santorium Schillerhöhe der Lva. Württemberg, and DR. MED. F. BÖHM, Heilstätte Uberruh der Lva. Württemberg, Isny. A volume of 138 pages, with 258 illustrations. Published by Georg Thieme Verlag, Stuttgart, 1955. Distributed in the United States and Canada by the Intercontinental Book Corporation, New York N. Y. Price DM 57.—($13.55)

This book is based on 3,213 bronchoscopic and 2,373 bronchographic studies of tuberculous patients. The authors feel that a bronchoscopic examination should be done whenever the slightest doubt as to the presence or extent of a tuberculous lesion exists. Their indications for bronchoscopy are thus rather broad. About two-thirds of the patients admitted to their hospital were studied by this means.

The findings are presented largely by way of case reports, the cases having been worked up very carefully. First a scout film is made, followed by a planigraphic examination of the lesion. Then the bronchoscopic and bronchographic examinations are carried out. The bronchoscopic findings are described in detail, often supplemented by sketches and colored photographs.

The changes in the bronchial tree due to pulmonary tuberculosis are discussed under the following main headings: Tuberculosis of the Parenchyma of the Lungs; Tuberculosis of the Endothoracic Lymph Nodes (the bronchoscopic findings before, during, and after the perforation of a lymph node

into the bronchus are vividly described); Pleuritic Processes (changes in the bronchial system due to exudate, scars, etc.); Active Methods of Therapy (pneumothorax, phrenic exeresis, resection). Tuberculosis of the bronchus itself, and its course, and cicatricial stenosis of the bronchus are treated in separate chapters.

The illustrations are excellent. The book is recommended not only to the radiologist, who will find interesting points to supplement his knowledge of the interpretation of the bronchograms, but also to the specialist in tuberculosis, the bronchoscopist, and the chest surgeon.

DIE BRONCHOGRAPHIE. Fortschr. a. d. Geb. d. Röntgenstrahlen Ergänzungsband 72. By DR. ERNST STUTZ, Dozent an der Universität Freiburg I. Br., and DR. HEINZ VIETEN, Dozent an der Medizinischen Akademie, Dusseldorf. A volume of 250 pages, with 181 illustrations. Published by Georg Thieme Verlag, Stuttgart, 1955. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York, N.Y. Price DM 66.—($15.70).

Since the lung markings as seen on plain films are due only to blood vessels and to disease, a contrast medium is necessary to demonstrate bronchi and bronchioles. Lipiodol has been accepted for this purpose for twenty-five years. Recently improved thoracic surgery has stimulated a search for a less toxic material. The result has been such water-soluble media as Bronchoselectan, Joduron B, and Methocel Diodrast, all of which utilize carboxymethylcellulose to control viscosity. Drs. Stutz and Vieten have completely turned to aqueous contrast agents as less injurious than Lipiodol. It should be noted however that carboxymethylcellulose is retained permanently in the lung but happens not to be radiographically visible.

After an introduction dealing with the choice of a medium, the authors consider the best methods of anesthetizing the tracheobronchial tree. These are fully detailed, since the newer media, being more acutely irritating than Lipiodol, require greater care in this respect. Discussions of the various routes of administration of the medium, of fluoroscopic control, and of film technic complete the first section of the book. In their writing of normal anatomy and physiology, the authors adhere to the practical. Modern segmental anatomy is charted and illustrated both with roentgenograms and line drawings.

The final section of the text is concerned with the structural changes in the bronchial tree as produced by disease. The little known though obvious alterations in the mucosa of the trachea and main stem bronchi in bronchitis are beautifully depicted. Bronchiectasis, the home field of bronchography, receives top attention. It is considered in terms of acquired, developmental, and acute forms. The differential diagnosis of lung abscess and tuberculosis follow. In so far as it is now established that a bronchogram is indispensable to the accurate localization of a neoplasm, a special effort has been made to produce a superb chapter on lung tumor. The middle lobe syndrome receives independent treatment, chiefly by reason of its current popularity. The bronchographic peculiarities which occur at times in silicosis, foreign body localization, congenital anomalies, syphilis, fungus infections, and radiation pneumonitis are also presented.

The text is concise, lucid, usable, and well indexed. The bibliography consists of 1,654 items alphabetically arranged by author, with no duplicate entries. This is in all phases a very fine book.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Cardiovascular System

The Digestive System

RADIOTHERAPY

RADIOISOTOPES

RADIATION EFFECTS; EXPERIMENTAL STUDIES

THE HEAD AND NECK

Venographic Clues to Localization of Intracranial Masses. Paul A. Riemenschneider and Arthur Ecker. Am. J. Roentgenol. **72**: 740–752, November 1954.

The authors discuss the value of visualization of the deep venous system of the brain in carotid arteriography as an aid in localization of intracranial masses. The deep veins of the brain form such a constant pattern that certain deviations from the normal can be interpreted as significant. Examples of such displacements are presented.

Suprasellar tumors produce upward displacement of the basilar vein of Rosenthal and stretching of the vein of the septum pellucidum. Frontopolar tumors show downward and backward displacement of the origin of the internal cerebral vein and consequently of the foramen of Monro. Associated with this there is a downward displacement of the vein of the septum pellucidum and the thalamostriate vein. Tumors of the anterior basal ganglia elevate the thalamostriate vein and at the same time displace the junction of this vein with the internal cerebral vein downward and backward. Parieto-parasagittal tumors flatten the vein of Galen and occasionally depress the inferior sagittal sinus. Tumors of the posterior corpus callosum widen the curve of the vein of Galen. In subdural hematomas, frequently the venograms will demonstrate more vividly than the arteriograms the displacement of vessels from the inner table, outlining the size and shape of the hematoma.

Tumors of the middle and posterior portions of the temporal lobe or extracerebral tumors in this general area tend to cause an upward displacement and humping of the basilar vein. Some of these cases also show upward displacement of the ampulla of Galen. The venographic changes resulting from large tumors in the cerebellopontine angle are similar to those described with masses in the temporal lobe. However, there are both stretching and a diffuse elevation of the basilar vein rather than the localized humping caused by temporal tumors. Pineal tumors produce an upward convexity on the curve of the vein of Galen.

The authors conclude that these venographic alterations can be the most significant clue in the localization of intracranial masses and the determination of their operability.

Twenty-four roentgenograms; 10 drawings.

THEODORE E. KEATS, M.D.
University of California, S. F.

Rupture of an Intracranial Aneurysm During Cerebral Angiography. Kenneth G. Jamieson. J. Neurosurg. **11**: 625–628, November 1954.

A 36-year-old white male was admitted with a history of severe headache precipitated by exertion. There were no neurologic signs, but the spinal fluid was bloody and a diagnosis of ruptured aneurysm was made. Nine days later, carotid angiography demonstrated an aneurysm of the left middle cerebral artery. One week after this, angiography was again undertaken to determine the surgical approach of choice. The left common carotid artery was punctured and 15 ml. of 40 per cent Uriodone was introduced in two to three seconds. A good anteroposterior view was obtained with a single injection but, due to technical error, three injections were required for the oblique lateral view. During the last of these, severe left frontal headache developed and the roentgenogram showed rupture of the aneurysm. A craniotomy was done with evacuation of a hematoma and ligation of the middle cerebral artery. The patient died ten hours later.

The author discusses the need for a less irritating contrast substance than the opaque solutions of the iodine group in common use. The degree of vascular disturbance produced by these media is evidenced by a scalding sensation of the face, a bright facial flush, and an elevation of blood pressure following injection. The facial flush was preceded by an intense unilateral pallor in the case reported. Instances of spasm in the carotid siphon and major carotid branches are also mentioned.

In 150 previous cases no other serious complications were observed. One patient had a transient hemiplegia with complete recovery after one hour. In another, acute bronchospasm occurred, which was relieved by adrenalin.

Two roentgenograms.

SAIM GOKHAN, M.D.
Mercy Hospital, Pittsburgh

Some Complications of Vertebral Angiography. Oscar Sugar and Paul C. Bucy. J. Neurosurg. **11**: 607–615, November 1954.

Serious complications in 3 patients undergoing vertebral angiography emphasize the potential dangers of this procedure. Two of the patients, aged forty-eight and sixty-nine years, died, and autopsy showed severe arteriosclerosis. The third patient, aged fifty-seven, recovered after the procedure had caused a marked increase in neurologic symptoms. In each of the 3 cases there was a history of headaches, homonymous hemianopsia, and other neurologic findings, without evidence of increased intracranial pressure, and in each the angiograms revealed evidence of arteriosclerosis of the vertebral-basilar system

The authors advise special precautions in the examination of patients with the symptoms mentioned above in whom skull roentgenograms are normal. They suggest that, when carotid angiography fails to reveal the lesion, it may be best to wait a week before attempting vertebral angiography. They point out, also, the advantage of using small amounts of contrast medium, carrying out the procedure under local anesthesia so that the patient's reaction is more evident, and allowing at least ten minutes between injections.

Three roentgenograms; 1 photograph.

PAUL R. NOBLE, M.D.
Mercy Hospital, Pittsburgh

Acute Occlusion of the Internal Carotid Artery. Report of Five Cases. William R. Chambers. Surgery **36**: 980–985, November 1954.

Acute occlusion of the internal carotid artery, due to an embolus or thrombosis or arising from arteriosclerosis, is probably much more common than is generally supposed. The symptoms may suggest a "stroke" with hemiplegic disturbances, or they may be intermittent and recurrent, suggesting multiple sclerosis. Palpation of the artery in the pharynx will demonstrate absence of pulsation, but carotid angiography is necessary for a positive diagnosis.

Simple failure of the carotid to fill is not sufficient to permit a diagnosis. Shapiro and Peyton (Neurology **4**: 83, 1954. Abst. in Radiology **64**: 880, 1955) listed six angiographic findings, of which the first four were considered most significant. These four are: conical narrowing of the injected medium before it stops, resulting in visualization of a stump or short segment of the artery; failure to fill the carotid artery and a defect in the column of contrast medium; retrograde flow of the medium in the common carotid artery and, on the right side, flow through the innominate to the vertebral artery; narrowing of the vessel and irregularities in its diameter. The author believes that the diagnosis is most certain when there is failure to fill on the suspected side with repeated attempts while on the good side it is possible to fill both internal carotid arteries across the circle of Willis.

While some patients recover spontaneously, and numerous surgical procedures have been used with varying degrees of benefit, prompt institution of anticoagulant therapy seems to be the best method for treatment.

Five illustrative case reports are presented.

Four roentgenograms. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Posterior Fossa Cysts Due to Congenital Atresia of the Foramina of Luschka and Magendie. M. Sofer Schreiber and R. D. K. Reye. M. J. Australia **2**: 743–748, Nov. 6, 1954.

Posterior fossa cysts due to congenital atresia of the fourth ventricle foramina are probably not so rare as the literature would indicate. In this developmental anomaly no opening forms in the roof of the fourth ventricle at its inferior end (foramen of Magendie). The lateral recesses of Luschka may also remain closed, and an unusual variety of non-communicating hydrocephalus results. Probably the great majority of cases occur in infants. Closure of the ventricular system does not, however, invariably result in a rapidly expanding hydrocephalus incompatible with prolonged life, for this lesion has been reported in fairly normal older children and adults. Compensatory mechanisms that have been postulated to produce a balance of cerebrospinal fluid dynamic pressure include small choroid plexuses producing less ventricular fluid than normal, absorption of fluid by the numerous vessels of the cyst wall, and the dialytic property of the cyst wall. A slight disturbance in any of these mechanisms may result in a state of intracranial hypertension. In some instances the foramina, while not atretic, may be inadequately opened with normal development until some extrinsic factor upsets the balance. Trauma is frequently responsible.

A series of 24 cases was analyzed, and the foramen of Magendie was found to be closed in all, with the foramina of Luschka patent in at least 3 instances. Emphasis is placed on the clinical difficulty of determining whether or not the hydrocephalus is communicating or not. It is generally considered that the foramina of Luschka have no function in the filling of the ventricles with air from below, as their mouths lie at the end of tortuous, narrow pathways presenting mechanical difficulty for entrance of gas but not for egress of fluid. This applies, however, only in the normal situation. With the fourth ventricle enormously dilated, these lateral pathways are less tortuous. In one case of the authors' series, air did pass through patent foramina of Luschka into the ventricles. Microscopic examination of serial sections is considered the only reliable method of establishing the patency of these foramina.

A pathognomonic sign of atresia of the foramina of Luschka and Magendie occasionally seen on plain skull films is a high transverse sinus. Dilatation of the fourth ventricle hinders the normal folding backward of the cerebral hemispheres which carries the sinuses downward. The transverse sinus then fails to descend, and its groove markings are present on the inferior parietal bone, rather than in the normal occipital location. Since skull markings generally are not well demonstrated in the first year of life, this sign is of value primarily in older patients. On a ventriculogram, diagnosis is suggested by upward and anterior displacement of the posterior and inferior horns of the lateral ventricles.

Six new cases are presented. In 2 there was an occipital meningocele associated with and decompressing a posterior fossa cyst. This condition should be suspected when such an occipital cyst is found to emerge from a hiatus, especially if it is situated above the external occipital protuberance.

Four roentgenograms; 2 photographs; 2 photomicrographs; 3 drawings. C. M. GREENWALD, M.D.
Cleveland Clinic

The Size of the Sella Turcica by Age and Sex. Lewis L. Haas. Am. J. Roentgenol. **72**: 754–761, November 1954.

The author describes a method for measurement of the sella turcica which he published some thirty years ago in Germany (Fortschr. a. d. Geb. d. Röngenstrahlen **33**: 419, 1925) and has modified to conform to today's technic. From a lateral view, the contour of the sella is traced on a transparent sheet of glass, Lucite, or cleared film. One of the heavier lines of a transparent millimeter paper or ruler is superimposed on the upper limits of the tracing and the squares covering the area are counted. Films for this purpose are made at a distance of 36 inches, with a Bucky grid and a film-table distance of 5.6 cm.

Measurements were made on persons of various ages from the University of Illinois Hospital, and it is concluded that, for practical purposes, 58 and 120 sq. mm. can be regarded as the limits of the normal sellar area in adults, 70 to 105 mm. representing the middle sizes. The mean for boys between three and seventeen years was greater than for girls. After this age, female sellae appeared slightly larger than male.

A sella of abnormal size, even in a patient without symptoms, usually has definite clinical significance. Measurements below normal indicate pituitary hypoplasia and may be a sign of present or previous endocrine disturbance. An abnormally large sella may be due to intra- or extrasellar factors. These the author lists as follows: (1) *Intrasellar:* (*a*) idiopathic, constitutional type; (*b*) hyperplasia, as in polyglandular endocrine disease; (*c*) pituitary tumors (though some tumors such as basophilic adenomas may cause little or no enlargement). (2) *Extrasellar:* (*a*) space-occupying suprasellar or parasellar lesions invading the sellar cavity directly; (*b*) any space-occupying intracranial lesion giving rise to increased intracranial pressure. Frequently a secondary internal hydrocephalus causes

dilatation of the third ventricle and it bulges into the sellar cavity.

Three graphs; 3 tables.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Localization of Parathyroid Adenomata by Arteriography. Sven Ivar Seldinger. Acta radiol. **42**: 353–366, November 1954.

Contrast filling of the inferior thyroid artery was obtained by injection through a polyethylene catheter introduced into the brachial artery after percutaneous puncture in the antecubital fossa by a technic previously described (Seldinger: Acta radiol. **39**: 368, 1953. Abst. in Radiology **62**: 466, 1954). The tip of the catheter lay in the subclavian artery, a little distal to the thyrocervical trunk.

Four cases are presented in which correct information regarding the localization of a parathyroid adenoma was obtained by this means. In 2 cases no information about the parathyroids was obtained. The diagnosis depends upon the demonstration of displacement of the inferior thyroid artery and its branches, including the enlarged parathyroid artery.

The blood supply of the parathyroids is derived, with few exceptions, from the inferior thyroid artery, which is a branch of the thyrocervical trunk. This latter vessel arises from the upper part of the subclavian artery, about 1 cm. distal to the vertebral artery and directly above the origin of the internal mammary artery. Having given off large muscular branches, it ascends under the name of the inferior thyroid artery and turns medially between the vertebral artery and the carotid sheath, reaching the middle of the posterior border of the thyroid lobe and curving downward to the neighborhood of its lower pole. After giving off small branches to organs and muscles in the vicinity, the artery divides into its terminal branches, which run mainly along the posterior surface of the thyroid. Some of these anastomose with the inferior thyroid artery of the other side, and with the superior thyroid artery, which arises from the carotid sinus and spreads mainly over the anterior surface of the thyroid. Each parathyroid gland is supplied by a minute special artery running to it. The artery may arise from any branch of the inferior thyroid artery, but whatever its origin, it supplies only the gland.

The adenomatous parathyroid may be of normal dimensions or as large as a hen's egg or larger. In diffuse hyperplasia, at least one of the two glands will reach a considerable size. The position of the adenomata is not identical with that of the normal glands. In addition to the embryological descent, adult parathyroid glands, particularly when enlarged, may be displaced caudally by gravity and intrathoracic suction. The displacement of adenomata in the superior gland is into the posterior mediastinum, while those of the inferior gland may be displaced into either the anterior or posterior mediastinum. They remain attached to their original arterial supply so that they are found displacing the vascular pedicle downward. Mediastinal adenomata may, however, develop in glands situated in the anterior mediastinum subsequent to their embryologic descent; these are not supplied from the inferior thyroid artery.

Seven roentgenograms; 3 drawings; 3 diagrams.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

The Roentgenological and Pathological Aspects of Tuberculosis of the Skull. José P. Tirona. Am. J. Roentgenol. **72**: 762–768, November 1954.

Tuberculosis of the skull begins in the diploe and extends to the outer or inner table, or both, in the form of a cone-like destructive process which is said by some to be characteristic. When both tables are involved, an hourglass deformity is produced. The frontal and parietal bones are most commonly affected. The foci may be single or multiple. Caseation is usually present. The author found 3 cases in a Philippine orthopedic hospital in five years and all were of the caseous type.

The roentgen signs of skeletal tuberculosis vary with the stage and degree of involvement. Early, slight bony changes are hidden by normal overlying bone. The first positive finding is osteoporosis, but this is non-specific. Later, a localized sharply demarcated area of bone destruction is present. If caseation occurs, a bone cavity may form. With healing, a dense ring may be seen indicating fibrous tissue formation. In children the integrity of the original bone may be reestablished.

Since the lesions are not sufficiently characteristic to permit an unequivocal diagnosis of bone tuberculosis from the roentgenograms, positive confirmation by tuberculin testing, bacteriologic study, and biopsy is indicated.

Four roentgenograms.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

The Anatomic-Radiographic Picture of Giant Osteomas in the Paranasal Sinuses. Giuseppe Muscettola. Arch. di radiol. **29 (n.s. 3)**: 3–22, 1954. (In Italian)

Osteomas are found for the most part in the frontal and ethmoid sinuses, less commonly in the sphenoid sinuses, and rarely in the maxillary. Giant osteoma cannot be considered rare. Because its course is slow and silent initially, it is impossible to say when the process begins. The impression of some authors that up to thirty years of age one should speak of a true osteoma and after thirty of a meningioma is not reliable.

The clinical picture of giant osteoma is characteristic whether the tumor is still contained within the sinuses and without complications, whether it has penetrated into the orbit or nasal or cranial cavities, or whether there are complicating inflammation and mucocele. The radiographic picture is also typical, at least in the majority of cases: an eburnated massive opacity within the sinus, usually separated from the sinus wall by a translucent border. Even when the neighboring cavities are involved, the tumor preserves its characteristics.

Many conditions of the sinuses and neighboring cavities can simulate the picture of giant osteoma. Most can be differentiated by careful evaluation and a complete radiographic study. Of the many sclerosing processes in the sinus (cavity and walls), the most difficult to differentiate is meningioma.

The radiographic examination is more useful for detection of the complications of giant osteoma (inflammation, mucocele, invasion into the surrounding cavities) than the clinical picture.

Eight roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Microradiographic Studies of the Auditory Ossicles (Malleus and Incus) and of the Osseous Labyrinth. K. Karlsson, A. Engström, and H. Engström. Acta radiol. **42**: 381–390, November 1954.

A study was undertaken to show the distribution of the mineral salts within the auditory ossicles of the middle ear and the hard bone tissue found in the osseous labyrinth. Using a previously described microradiographic technic (Engström, A: Acta radiol. Suppl. 63, 1946) which registers with a resolution of better than 0.5 micron, the authors studied finely polished bone sections with a final thickness of 100 to 200 microns. Simultaneous radiography of thin bony specimens and an aluminum foil step wedge made it possible to express roentgen absorption of the bone material in equivalence of aluminum absorption.

Results show that there is a highly mineralized zone around the caput mallei. There is less mineralization around the haversian systems in the central portion of the osseous structure. In the incus, approximately the same degree of mineralization was found in both the outer layer and central portion. In the osseous labyrinth there are islets of high mineralization about newly formed haversian systems. In addition, a high mineral content was found around the blood vessels and around the semicircular canal.

This research procedure is to be used further in an investigation of osteosclerotic processes.

Eleven microradiograms; 2 diagrams.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

THE CHEST

Bronchography. Technique and Choice of Contrast Media. Earl E. Gudbjerg. Acta radiol. **42**: 367–373, November 1954.

The author believes transglottic injection of contrast material to be the method of choice in bronchography. It is easy on the patient, is simple to perform, and produces good results. A suspension of 5 gm. of sulfadiazine in 20 ml. of iodized oil is considered the best medium available. It does not produce local irritation, affords good contrast, and is free from toxic reactions. The high viscosity prevents alveolar filling, and for this reason the medium should not be warmed before injection. Elimination by coughing is prompt, being complete in a few hours to a few days.

Five roentgenograms.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Lobar Agenesis of the Lung. Clifford F. Storey and Albert G. Marrangoni. J. Thoracic Surg. **28**: 536–543, November 1954.

A white male of 21 years had a mild cough and shortness of breath with a pronounced wheeze over the left chest, which had increased in the past two years. Chest fluoroscopy showed an increased radiolucency of the left lung field suggesting emphysema. The heart was displaced to the left. The mediastinum shifted rather sharply to the right on expiration and returned to the left on inspiration. The bronchovascular markings were diminished on the left side. At bronchoscopy, the left main stem bronchus was found to be longer than usual, with a fusiform narrowing to a very small caliber. Bronchograms demonstrated these same findings, showing stenosis of the left main-stem bronchus and absence of a lower lobe bronchus. The three segmental bronchi of the left upper lobe were well visualized, and the lobe was seen to be the site of a marked cylindrical bronchiectasis.

At operation the left pleural cavity was clear and no fissure was found. A small structure, the size of a man's thumb, was attached to the diaphragmatic surface of the left upper lobe. This structure was not air-containing and it was considered to be a vestigial remnant of the left lower lobe. Examination of the gross specimen showed a left upper lobe, the size and shape of a lung. Attached to the base of the lobe was the vestigial remnant of the lower lobe.

The authors discuss the etiology of lobar agenesis. It is said to occur between the 5- and 7-mm. stage of embryonic development. There is either complete absence of lateral buds or of development of the main-stem bronchial buds. Agenesis of the lung is three times more common on the left than on the right, and is seen more often in males than in females. The authors state that this is the third case of agenesis of the left lower lobe with congenital stenosis of the left main-stem bronchus to be anatomically proved, the second to be confirmed at operation, and the first in which the correct diagnosis was made preoperatively.

Three roentgenograms; 2 photographs.

RENE G. FORTIER, M.D.
St. Paul, Minn.

Undetected Tuberculosis in Various Economic Groups. Robert J. Anderson, Philip E. Enterline, and Otis D. Turner. Am. Rev. Tuberc. **70**: 593–600, October 1954.

Statistical reports indicate that there is a heavy tuberculosis mortality in lower economic groups. In a study of case finding by mass survey methods the authors found a much more even distribution of undetected tuberculosis at various economic levels than mortality figures would indicate. It is possible that the economic loss resulting from a chronic disease such as tuberculosis is a major factor in producing the difference in statistics between newly discovered cases and deaths, so far as economic level is concerned. The ratio between the lowest and highest economic groups was found to be 20 to 1 tuberculosis deaths, 3 to 1 known cases of tuberculosis, and only 1 1/2 to 1 case of tuberculosis previously undetected. Because of the relatively high incidence of undetected tuberculosis in the higher economic groups, it is concluded that these groups should not be overlooked in tuberculosis detection programs.

One chart; 4 tables.

JOHN H. JUHL, M.D.
University of Wisconsin

Some Serious Complications of Tuberculous Lymph Nodes: Fatal Hemoptysis, False Aneurysm, Occluded Cisterna Chyli and Obstructive Jaundice. A Review with a Report of Five Cases. Godfrey L. Gale. Am. Rev. Tuberc. **70**: 610–622, October 1954.

Five cases of serious complications associated with lymph-node tuberculosis are reported. Four were fatal. The patient who survived had obstructive jaundice due to pressure on the common bile duct by enlarged tuberculous nodes in the region of the first portion of the duodenum. Fatal hemoptysis in 1 case was due to erosion of a bronchial artery by an adjacent tuberculous node. One patient died of hemorrhage from a

false aneurysm of the abdominal aorta produced when a sloughing tuberculous lymph node eroded the aorta in one place and the third portion of the duodenum in another, resulting in a communication between the aorta and the duodenum. Death from gastrointestinal hemorrhage occurred three days after onset of the bleeding. The third death due to hemorrhage was the result of erosion of a varicose vein in the upper esophagus. There was a small ulcer in the esophagus at about the level of the cricoid cartilage, communicating with a caseous node and the vein. Occlusion of the cisterna chyli by tuberculous granulation tissue resulted in slow deterioration, leading to death six months after surgical excision of a tuberculous lesion of the shaft of the right fibula. The surgery resulted in spread of the tuberculosis to the inguinal, iliac, and para-aortic nodes up to the cisterna chyli.

All of these complications are unusual, and it is felt that long term antimicrobial drugs should decrease their incidence even further.

Three roentgenograms; 2 photographs; 2 drawings.

JOHN H. JUHL, M.D.
University of Wisconsin

Pulmonary Histoplasmosis with Cavitation. Edith Mankiewicz, F. Blank, and Jack H. Rubin. Canad. M. A. J. **71**: 386–387, October 1954.

Only a few examples of pulmonary histoplasmosis associated with cavitation have been described. The authors report a case in which *Histoplasma capsulatum* was isolated on two occasions from the sputum. A postero-anterior chest film revealed abnormal shadows in both lung fields, with a large radiolucent area on the right, suggestive of a cavity. Tomograms taken at 1-cm. intervals disclosed a cavity measuring about 5 cm. in diameter in the anterior portion of the right upper lobe and, immediately below this, another cavity measuring 2 cm. Two (possibly four) cavities were seen in the apical portion of the left lung, with signs suggestive of bronchiectatic changes.

Mantoux tests, in dilutions ranging from 1 in 10,000 to 1 in 10, were negative, and sputum and laryngeal swab cultures, taken on five occasions, failed to reveal evidence of *M. tuberculosis*.

One tomogram.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Pneumoconiosis from Exposure to Kaolin Dust: Kaolinosis. Kenneth M. Lynch and Forde A. McIver. Am. J. Path. **30**: 1117–1127, November 1954.

Sufficient exposure to inhalation of dust of at least some kaolin deposits will cause in some individuals a chronic fibrous disease of the lungs that may be disabling and even fatal. The term kaolinosis is used to signify this definite disease state, beyond the mere location of kaolin in the lungs. Two fatal cases are reported here. One patient, aged thirty-six, had worked in a plant processing kaolin for use in various industries for seventeen years, and the other, aged thirty-five, for about twenty-one years. Both had probably been exposed to very dusty atmospheres in the early period of their employment.

Roentgen examination in each of these cases showed advanced pneumoconiosis with infection, confluent consolidation, and nodular infiltration; cavitation and emphysema were also present in the one patient. While the roentgenograms in these 2 cases apparently do not furnish features upon which definite differentiation between silicosis and kaolinosis may be made, there are two observations of possible significance that may be made from them. The first is that, while the same features may occur in cases of silicosis, the massiveness of the involvement of the upper parts of the lungs in kaolinosis is remarkable. Kaolin dust is composed of very fine particles and is comparatively light, possibly having a better opportunity to reach the upper lung areas than do heavier dusts composed of larger particles. Secondly, although much pulmonary air space is obliterated, emphysema is prominent in the open areas.

A bluish color created by the deposits in the lungs was a distinctive feature. While the reactions causing the development of blue color in clay materials are apparently not clearly understood, it is believed that, because of their absorptive qualities, clay crystals when mixed with organic amino compounds may develop a blue reaction under some conditions.

Associated vascular lesions were prominent, consisting of extensive obliterative arteritis with visible particles of foreign material scattered through the vessel walls, even in the fibrous tissue which occupied the lumina of some arterial branches, and, in the first case, thrombosis of the main branches of the pulmonary artery.

One roentgenogram; 4 photomicrographs; 2 photographs.

Tuberculo-Silicosis. F. S. du Toit. South African M. J. **28**: 845–850, Oct. 2, 1954.

The author quotes Simson's definition of the term "infective silicosis" as designating the characteristic and distinctive lesions, marked by excessive fibroid reaction, which certain infections produce in the silicotic lung. Such lesions are most commonly the result of tuberculosis, so-called "tuberculosilicosis." By the standards of the Silicosis Medical Bureau of Johannesburg (South Africa), "when a man's roentgenogram shows more fibrosis in the lung tissue than would be expected at his age, and if, with this, there is evidence or presumptive evidence of even slight previous tuberculous infection of the hilar or peribronchial regions, then the condition is regarded as infective. . . he is not accepted for underground work."

It is impossible to make a definite roentgen diagnosis of tuberculosilicosis, even if the x-ray film shows evidence of silicosis, as long as the lesion is in its initial stage. Later, the diagnosis can be made with reasonable certainty, especially when the clinical condition and the findings are in accord. In the more advanced cases, the diagnosis becomes somewhat easier. The nodular fibrosis is not so clearly defined [as in uncomplicated silicosis?] and is more irregular both in appearance and distribution. Of perhaps even greater importance are the areas of consolidation, which are usually well defined and slowly progressive. These, with the increased shadows in the hilar areas, make the diagnosis of tuberculosilicosis fairly certain. In some cases several years elapse before any increase in the size and density of the opacities can be seen. Serial films are therefore of importance.

The condition which is hardest to distinguish from tuberculosilicosis is fibroid tuberculosis. In the latter condition the lesion is most commonly found in the upper half of the lungs and only seldom in the lower; there is a gradual shifting of the trachea and medias-

tinum toward the affected side, and the process generally develops more slowly than tuberculosilicosis. Other conditions which may cause confusion include neoplasms (primary and metastatic), benign tumors, fungous infections, and abscess. The clinical investigation and serial roentgenograms will in most cases make the differential diagnosis comparatively easy.

The development of tuberculosilicosis is entirely independent of the degree of silicosis present—the cases cited by the author show that it may occur with minimal degrees of silicosis. The lesions may develop in any part of the lung, but the upper lobes are more frequently involved. Active tuberculosis is the final outcome in the large majority of cases.

Ten typical case histories with postmortem findings are included.

Ten roentgenograms. STEPHEN N. TAGER, M.D.
Evansville, Ind.

Spontaneous Regression of Pulmonary Metastases of a Chorioepithelioma. W Rübe. Fortschr. a. d. Geb. d. Röntgenstrahlen **81:** 638–642, November 1954. (In German)

The so-called malignant chorioepithelioma is believed to have a very unfavorable prognosis, and pathologic and clinical observations of healing or healed metastatic lesions are almost unknown.

The author reports a case with a five weeks history of minimal lower abdominal pain and slight bloody discharge from the vagina. Histologic study of curettings revealed malignant chorioepithelioma. A hysterectomy was performed, at which time metastatic lesions were found in the pelvic cavity. Less than two weeks postoperatively "cannon-ball" formations were noted in both lungs. Seven weeks later the pulmonary lesions appeared smaller, and after nine months the lungs were almost clear.

Histopathologically, the benign chorioepithelioma cannot be differentiated from the malignant form. On the other hand, a negative Aschheim-Zondek test suggests a relatively benign process and a positive test a malignant type.

In the reported case the Aschheim-Zondek test was negative. Another favorable factor was the early detection of the disease.

Three roentgenograms. ERNEST KRAFT, M.D.
Newington, Conn.

Chylothorax (Chyloptoe) with Pseudo-Miliary Lesions in the Lungs. Case Report. W. Löffler and G. Jaccard. Schweiz. med. Wchnschr. **84:** 1335–1336, Nov. 27, 1954. (In German)

Deviations (shunts) of the chyle stream are relatively rare but always impressive occurrences, confronting the physician with interesting diagnostic and therapeutic problems. The authors observed a case which they considered worth reporting.

In 1947, at the age of 28 years, a white female had a slowly developing left-sided pleural effusion, causing a right mediastinal shift. From the first aspiration of pleural fluid, the diagnosis of chylothorax was established. No explanation for the condition could be found. There was no history of injury and no evidence of phlebitis in the upper thorax. Pulmonary tuberculosis was not present, and the serological findings were negative. Eight aspirations of pleural fluid were done between January 1947 and March 1948, yielding 11.9 liters of chyle. Following the last aspiration, there was regression of the effusion and the patient remained well for a year and a half, after which time she again became dyspneic, with expectoration of yellowish phlegm.

In May 1950, more than two years after the last thoracentesis, fine reticulonodular lesions were observed in the right middle and both lower pulmonary fields, exhibiting the x-ray picture of lymphangitis or hematogenous miliary spread. Antibiotic therapy was ineffective and symptoms increased. In April 1951, the patient complained of extreme dyspnea and frequent coughing spells with expectoration of 100 to 300 c.c. of fluid daily. The expectorated material was of unusual appearance, showing yellow filiform strands of muco-elastic-fatty consistency, which, when placed in water, kept their coherence. In configuration they resembled the bronchial tree. Chemical analysis of the sputum revealed mostly lipoids, soluble in ether.

Direct proof of the passage of chyle into the bronchial tree could not be established but was assumed, mainly because of the type of the sputum, which microscopically resembled thickened concentrated chyle. No explanation of the mechanism by which the chyle entered the bronchial tree was found.

The pseudomiliary lesions in the lower lungs presented a picture which can be considered rather characteristic.

Four illustrations, including 3 roentgenograms.
HERBERT POLLACK, M.D.
Chicago, Ill.

Differential Diagnosis of Paramediastinal Clouding of the Right Upper Lobe and Superior Mediastinal Pleurisy. P. Ch. Schmid. Fortschr. a. d. Geb. d. Röntgenstrahlen **81:** 629–637, November 1954. (In German)

According to the recent literature, widening of the superior mediastinum to the right in children is due chiefly to mediastinal pleurisy. This impression is supported by the observation that the lower border of the abnormal shadow may taper off laterally at the horizontal fissure or may even extend into the fissure. The author has found atelectasis to be a more common cause of paramediastinal shadows, involving either the entire right upper lobe or its anterior segment only. Findings in favor of atelectasis and against pleurisy are a sharp demarcation and a horizontal lower border, shift of the trachea and mediastinum to the right, elevation of the right hemidiaphragm, and some retraction of the right hemithorax.

The anterior segment of the right upper lobe bronchus branches off almost at right angles and is surrounded frequently by lymph nodes, which are potential predisposing factors for an atelectasis. In ordinary infections the atelectasis may disappear after a short time, while in a tuberculous process it may persist for many months. When this process becomes arrested, a pulmonary scar may remain, which simulates pleural thickening.

In the differential diagnosis thymic enlargement must be considered also. The thymic shadow is not as sharply demarcated and not as dense as an atelectasis and is located still more anteriorly.

Four examples of atelectasis are illustrated. A bronchogram in the last case shows obstruction of the anterior segment of the right upper lobe bronchus.

Seven roentgenograms; 6 drawings.
ERNEST KRAFT, M.D.
Newington, Conn.

THE CARDIOVASCULAR SYSTEM

Heart Volume Determination on Microfilms. Gunnar Lindgren and Sven Odén. Acta radiol. **42**: 375–380, November 1954.

Since September of 1951 the authors have been using microfilm examinations, postero-anterior and lateral, for routine determination of the heart volume. The heart diameters are measured in millimeters directly on the microfilm without magnifying apparatus. The present report is based on 150 cases chosen more or less at random for study.

On comparison of the results of the microfilm heart technic with those of the ordinary teleroentgenographic technic, it was noted that the error was approximately the same in the two methods, the standard deviation amounting to 1 to 2 per cent of the measured mean diameters. The error for single determinations on microfilm as a percentage of the average (the coefficient of variation) was approximately 2 for length and breadth of the heart, 3 for the sagittal diameter, and 5 for the volume of the heart. The results using ordinary roentgenographic and microfilming technic are thus practically the same.

According to the authors, the advantages of the chest microfilm technic are the saving of films and the fact that a technician is able to carry out such an examination near the individual's place of employment.

Three photographs; 3 diagrams.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

The Surgery of Infundibular Pulmonic Stenosis with Intact Ventricular Septum (A Type of "Pure" Pulmonic Stenosis). Robert P. Glover, Thomas J. E. O'Neill, Hugo Gontigo, Thomas C. McAuliffe, and C. Robert E. Wells. J. Thoracic Surg. **28**: 481–503, November 1954.

The authors present 6 cases of pulmonic stenosis of the infundibular type in which the ventricular septum was intact.

The most frequent symptom of pure pulmonary stenosis is dyspnea, usually noted on exertion and out of proportion to the degree of cyanosis. The latter is usually absent; when present, it is due to peripheral venous unsaturation. Easy fatigability may be associated with the dyspnea, and squatting may occur, though less commonly than with the tetralogy of Fallot. On fluoroscopy the heart appears normal or moderately enlarged. The apex is often elevated and the pulmonary conus is convex. The pulmonary artery and its main branches at the hilus are usually enlarged but quiet, though a jet pulsation into the left pulmonary artery may be seen at times. The lung fields are clear. Right ventricular enlargement is suggested in the frontal views and is confirmed in the oblique positions.

A definite diagnosis of this malformation can be made only by cardiac catheterization. With this procedure the pressures in the right atrium are usually found to be elevated. Systolic pressure in the right ventricle is always increased, probably in direct relation to the degree of stenosis. The pulmonary artery pressures are likely to be decreased but may be normal.

On angiocardiography the injected medium follows a normal course. Indirect angiocardiographic signs of pulmonary stenosis are retention of the medium in the right ventricle, poststenotic pulmonary artery dilatation, and decreased vascular markings in the outer two-thirds of the lung fields. The stenotic area can be directly visualized by a special angiocardiographic technic whereby the injection is made directly into the entrance of the outflow tract of the right ventricle.

The trilogy of Fallot may be differentiated from pure pulmonic stenosis by cardiac catheterization and angiocardiography. At present valvular stenosis cannot be definitely differentiated clinically from infundibular or combined stenosis. Fullness or convexity of the pulmonary artery segment suggests the presence of a large poststenotic dilatation of the pulmonary artery and thus favors a valvular type of stenosis. Straightness or concavity of the pulmonary artery segment, on the other hand, suggests the presence of a normal or hypoplastic pulmonary artery with an infundibular rather than a valvular stenosis. Continuous recording of pressures during withdrawal of the catheter from the pulmonary artery under fluoroscopic guidance is the best available method of differentiating the various types of stenosis. In pulmonary valvular stenosis there are a sharp rise of the systolic pressure and a fall of the diastolic pressure to zero or negative values at the level of the pulmonary valve. In infundibular stenosis the systolic pressure is approximately the same in the pulmonary artery and in the infundibulum distal to the stenosis; proximal to the stenosis, however, there is a sharp rise in systolic pressure; diastolic pressure falls at the level of the pulmonary valve and remains constant in the right ventricle. In combined valvular and infundibular stenosis there is a rise in the systolic pressure in the region between the valvular and the infundibular stenosis, followed by a second rise proximal to the infundibular stenosis; the diastolic pressure falls proximal to the valvular stenosis and is then of the same magnitude in the right ventricle proximal and distal to the infundibular stenosis.

In 5 of the authors' cases the infundibular location of the stenosis was suggested preoperatively by roentgenographic means and cardiac catheterization. In all 6 of the patients the diagnosis was confirmed at surgery. After surgery 4 of the patients are now functionally normal, and 2 others treated more recently show definite improvement at seven and six months, respectively. The authors have now operated upon 25 cases of pulmonic stenosis with intact ventricular septum without mortality. A description of the surgical technic is included.

Three roentgenograms; 6 drawings; 3 tables.

RENE G. FORTIER, M.D.
St. Paul, Minn.

Pulmonary Arteriovenous Fistula and Telangiectasia. Eugene Weiss and Benjamin M. Gasul. Ann. Int. Med. **41**: 989–1002, November 1954.

In pulmonary arteriovenous fistula a saccular vascular dilatation occurs at the junction of a pulmonary artery and vein, causing shunting of blood without its passing through the lung capillaries. The syndrome of cyanosis, clubbing of the fingers, and polycythemia, in the presence of a normal heart, with x-ray evidence of what appears to be a localized pulmonary lesion of vascular origin, makes the diagnosis almost a certainty.

Cyanosis is the most common feature of the disease, and is the result of the shunting of unoxygenated blood to the general circulation. It is not associated with any subjective evidence of illness and is usually out of proportion to the amount of dyspnea.

Compensatory polycythemia usually reaches 6,000,000 to 7,000,000 red blood cells, but counts exceeding

10 million with hematocrits up to 90 have been described. However, the blood picture may be normal, or anemia may be present as a consequence of severe and repeated bleeding from hemoptysis or from the gastrointestinal tract.

Hemangiomata may be present in the skin or mucous membranes, being manifestations of the underlying generalized, usually hereditary, vascular dysplasia. In the nose or mucous membrane lining the respiratory or gastrointestinal tract, their weak walls make them liable to rupture, accounting for the frequent episodes of epistaxis, hemoptysis, or hematemesis.

Central nervous system manifestations of the disease are numerous and varied. There may be headaches, vertigo, weakness, fainting attacks, dizziness, paresthesias, pain, diplopia, repeated epileptiform seizures, and even hemiplegias.

A lobulated or round discrete mass is usually seen on the chest film, connected by two or more linear shadows with the hilus. These linear shadows represent the afferent and efferent vessels. They are usually larger than other vessels in their vicinity, and their course is more tortuous. Fluoroscopically, the mass may be seen to decrease in size in Valsalva's maneuver and to increase in size in Müller's maneuver.

Routine films may fail to show the presence of a lesion. For that reason, angiography, in the posteroanterior and oblique projections, and tomography should be done routinely in all suspected cases, particularly when surgery is contemplated. A lesion obscured by the diaphragm or heart may be brought out only by this method.

One hundred and forty-nine cases of pulmonary arteriovenous fistula were reviewed by the authors, including those in the literature and 5 reported here for the first time. Among the 149 cases were 4 in which the usual saccular dilatation or fistula was not found, but the unoxygenated blood was shunted instead through numerous small telangiectases. One of the authors' cases, reported here in full, with autopsy findings, was of this type.

Two tables.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Hereditary Hemorrhagic Telangiectasia: A Report of Pulmonary Arteriovenous Fistulae in Mother and Son: Medical (Hormonal) and Surgical Therapy of This Disease. Edward C. Heyde. Ann. Int. Med. **41:** 1042–1054, November 1954.

In a family of 36 members for which histories were available, there were 7 with signs of hereditary hemorrhagic telangiectasia and 4 others who may have had the disease. Since 20 members of the family were young, it is believed that other cases may subsequently appear. Two of the patients, a mother and son, were found to have associated pulmonary arteriovenous aneuryms (fistulas), and a third member of the group had died from what appears to have been rupture of a large pulmonary fistula.

No statistics were available in the literature as to the incidence of pulmonary arteriovenous fistula in patients with hereditary hemorrhagic telangiectasia, but in series of pulmonary aneurysms 50 to 60 per cent of the patients have been found to have cutaneous or mucosal telangiectases. In view of this latter observation, the presence of telangiectases and a family or personal history of epistaxis should create a high index of suspicion of pulmonary involvement.

In the mother and son described here, the lung lesions were asymptomatic, since the fistulas were not large enough to produce a major arteriovenous shunt. When a large shunt occurs, the patient may exhibit such symptoms as dyspnea, palpitation, dizziness, chest pain, and headache, with cyanosis, clubbing of the fingers, pulmonary murmurs, and laboratory evidence of a compensatory polycythemia.

Fluoroscopy is helpful in identifying the fistulas. If the patient is rotated slowly, a mass may become visible which can be shown by the Valsalva and Müller procedures to be vascular in nature. Angiocardiography will usually afford a conclusive diagnosis.

Patients with arteriovenous pulmonary fistulas associated with hemorrhagic telangiectasia are subject to two hazards: (1) Serious bleeding can result from even a relatively small lesion. (2) Brain abscess is more likely to occur in these patients because of the passage of bacteria through the fistula without the protective filtering action of the lung.

Surgical resection is the treatment of choice for the pulmonary fistulas. Hormonal therapy (estrogens in females and estrogen-androgen tablets in males) may be helpful in controlling the epistaxis due to mucosal telangiectases.

Eight roentgenograms; 1 table.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Abdominal Aortography. David M. Gould and James K. V. Willson. Am. J. M. Sc. **228:** 586–598, November 1954.

This paper, presented under the heading Progress of Medical Science, reviews the literature on abdominal aortography and furnishes a comprehensive bibliography. The present status of the procedure is summarized as follows:

"Abdominal aortography, in common with angiocardiography and cerebral angiography, is a dynamic Roentgen method which demonstrates the lumen of a vascular system by the injection of radio-opaque contrast substances into the circulation. It is the method *par excellence* for the demonstration of vascular abnormalities of the aorta and its branches. Congenital anomalies, aberrant vessels, ectopic vessels, arteriovenous fistulae, aneurysms, thrombi, emboli, stenoses, occlusions, Leriche syndrome, collateral circulation, atherosclerosis and thromboangiitis obliterans are demonstrated in a detailed and frequently definitive manner.

"The kidney lends itself particularly well to analysis. Much information can be gained by aortography concerning such conditions as aplasia, hypoplasia, aberrant vessels, ectopia, duplication, horseshoe kidney, urinary stasis, hydronephrosis, ureteropelvic obstruction, calculus, tuberculosis, polycystic kidneys, cysts, neoplasms, infarct, and the 'Goldblatt' kidney.

"From the vascularity, inferences can be drawn concerning the status of certain abdominal and pelvic organs and structures. Diseases of the spleen, liver, adrenal, ovary, uterus, bladder, para-aortic and retroperitoneal tissues are recognizable.

"There have been few serious complications in abdominal aortography and even fewer fatal reactions. In the few fatalities reported, most of these have been

due either to renal damage or hemorrhage from the puncture site."

Venography and the Approach to Varicose Veins. Ian F. K. Muir, Eric H. Mucklow, and Anthony J. H. Rains. Brit. J. Surg. **42:** 276–282, November 1954.

While venography is neither practical nor necessary in the routine management of varicose veins, it is of value as a research technic in checking the results of a physical examination and it may be of aid in cases where additional information is required before a course of treatment is undertaken. The authors report their experience in the examination of over 50 limbs.

A tourniquet is placed around the leg above the ankle to occlude the superficial veins. Contrast material—20 to 40 c.c. of 35 per cent Diodone—is then injected into one of the superficial veins of the dorsum of the foot while the patient stands upright. The pressure of the tourniquet forces the contrast material into the deep venous system of the leg. Anteroposterior and lateral views are then made with the patient still upright, and a good filling of the veins is ordinarily obtained. In a few cases filling was observed under the fluoroscope and some idea as to the way in which contrast material (and presumably blood) is carried back from the distal portions of the foot and leg was gained.

Demonstration of incompetence of the communicating veins with reflux of contrast material from the deep circulation to the superficial circulation is thought to be the earliest sign of developing varicosities. The greater strain thrown upon the unsupported superficial veins with their weak valves, under these circumstances, leads to varicosity. These communicators can be reliably demonstrated below the knee by the method described.

The authors present examples and descriptions of what they consider the normal venous system, early varicose changes, and frank varicosities. Operative findings in patients with varicose veins are then compared with clinical findings and with radiographic findings and a reasonably good correlation is shown to exist.

Eleven venograms. J. W. BARBER, M.D.
Cheyenne, Wyo.

An Unusual Case of Thrombophlebitis and a New Type of Venogram. M. F. A. Woodruff. Australian & New Zealand J. Surg. **24:** 149–150, November 1954.

A case is reported of thrombosis of the left common iliac vein in which the diagnosis was confirmed by a new type of venogram. The technic used was that Begg (Brit. J. Radiol. **27:** 318, 1954. Abst. in Radiology **64:** 767, 1955). A special trocar and cannula, of approximately the diameter of a 17-gauge needle, was introduced into the greater trochanter of the left femur. Twenty cubic centimeters of 50 per cent Uriodone was then rapidly injected through the cannula and two anteroposterior films were taken, one as soon as all of the medium was introduced and the other about 4 seconds later. The venograms obtained were far superior to any others the writer has seen. They showed that the left common iliac vein was completely obliterated and that venous return from the left lower limb was dependent on large venous channels linking the two internal iliac veins. The condition was treated by ligating the left common iliac vein at its junction with the vena cava.

One roentgenogram. WYNTON H. CARROLL, M.D.
Shreveport, La.

Venography in the Diagnosis of the Cruveilhier-Baumgarten Syndrome. Charles M. Caravati and James M. MacMillan. Gastroenterology **27:** 598–603, November 1954.

The umbilical vein normally becomes obliterated shortly after birth and in later life is not patent except under certain pathologic conditions. Patency of the vein together with a congenital hypoplasia of the portal system, resulting in a high-grade portal hypertension with hepatic atrophy and a marked collateral umbilical circulation, constitutes the so-called Cruveilhier-Baumgarten syndrome. A case of this type is reported which was recognized clinically and by x-ray studies before death. There were no visible veins in the region of the umbilicus but a continuous umbilical hum was present. An incision was made to the left and below the umbilicus and in the subcutaneous tissues the tortuous vein, about 1 cm. in diameter, was exposed. A cannula was inserted and ligated in place. The patient was then carried to the x-ray room, where about 20 c.c. of Diodrast was injected in the dilated vein and films were obtained immediately. A large, tortuous vessel coursing upward from the umbilicus to the region of the liver bed was demonstrated. This was thought to represent a patent umbilical vein. Large anterior abdominal wall veins coursing downward and communicating with vessels in the region of the groin were also visualized. The patient's progress was downward and a cholemic death ensued. Autopsy findings confirmed the presence of direct blood flow from the portal vein by way of the patent umbilical vein into the epigastrics. A brief discussion of collateral circulation occurring during portal hypertension with emphasis on embryologic circulation in the falciform ligament is also given.

Two roentgenograms; 2 photomicrographs; 2 diagrams. WYNTON H. CARROLL, M.D.
Shreveport, La.

THE DIGESTIVE SYSTEM

Roentgen Examination of the Upper Gastrointestinal Tract. J. E. Miller. Texas State J. Med. **50:** 766–771, November 1954.

There are three phases of examination of the upper gastrointestinal tract: (1) technical performance, (2) recognition of abnormality, and (3) interpretation of abnormal findings. The author devotes this paper to the technical aspects.

He begins the examination by giving the patient 4 ounces of barium mixture at 8 A.M. A series of 5 films is obtained within an interval of ten minutes, followed by two polygraphs in the next ten minutes. Film size is 10 × 12 inches and views are taken of the stomach with the patient in various positions. Each of the polygraphs consists of four 5 × 6-inch exposures of the duodenal bulb with the patient oblique or prone. Fluoroscopic assistance is employed for centering the bulb for these views.

The seven films are processed and available for inspection before the radiologist commences his fluoroscopic examination at 10 A.M. A second 4-ounce cup

of barium suspension is given at that time, the passage of the medium through the upper gastrointestinal tract is observed, and spot films are obtained as indicated. Fluoroscopy is done in both the upright and the horizontal position. If a hiatus hernia is suspected, a thick barium paste is administered and polygraphs are made of the esophagogastric junction in the same manner as of the duodenal bulb.

About thirty minutes after the fluoroscopic examination, the patient is given 2 more ounces of barium and a 14 × 17-inch postero-anterior film of the abdomen is obtained. On this last film, the first dose of barium usually is shown to be in the terminal ileum and right colon, the second dose in the jejunum, and the third in the stomach.

The examination is concluded in most cases after a total interval of about three hours. If there are indications of an intestinal disorder, the patient is held longer for other films of the small intestine.

Eleven roentgenograms.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

The Neglect of the Gastro-Duodenal Mucosa by Clinicians and Radiologists. V. J. Kinsella. M. J. Australia **2**: 511–513, Sept. 25, 1954.

The importance of roentgenograms in addition to fluoroscopy to demonstrate mucosal patterns in the upper digestive tract is stressed. The technical procedures, according to the author, should include: proper positioning of the patient; use of the air naturally present in the stomach to provide double contrast; compression with mechanical devices; multiple spot filming. These measures are particularly useful in cases of chronic gastritis. In this serious condition, proper films of the mucosal pattern in conjunction with clinical, gastroscopic, and laboratory findings afford the greatest measure of diagnostic accuracy.

Some of the radiological signs of chronic gastritis depend upon secretory, motor, and vascular disturbances; others are related to gross anatomical disruption of the mucosa by erosions and small-cell infiltration and fibrosis. The author lists the following: transverse striae imposed upon the normal parallel longitudinal striae of the body of the stomach, producing a step-ladder pattern; interruption of the longitudinal rugae; coarse and fine mammillations; cauliflower and cerebriform patterns; polypoid appearances; a "craggy" outline; erosions (a term used to describe a breach in the mucosa which does not extend through the muscularis mucosae) which produce spots or scalloping of the edge or the pseudo-niche; the changing irritable "writhing" pleomorphic stomach; the pyloric filling defect, sometimes with mucosal prolapse; various forms of chronic pyloric obstruction; mucous effects, "flecked," or "layered"; the ghost stomach; the "patchy" stomach, especially with ghost pattern in the antrum or along the lesser curvature and excessively coarse rugal pattern along the greater curvature; the totally "disrupted" mucosal pattern; stiffness of the rugae detected by palpation under the fluoroscopic screen.

Difficulties in reaching a definite diagnosis at times are obvious. A radiologist must develop a group of norms in his own mind, based on his particular technic of examination. He can then describe objectively the deviations which he sees, whether of function or of structure, leaving to the clinician the task of evaluating the significance to the particular patient of these deviations.

SAIM GOKHAN, M.D.
Mercy Hospital, Pittsburgh

Transpyloric Prolapse of the Gastric Mucosa. Mario Cerati. Arch. di radiol. **29** (**n.s. 3**): 50–67, 1954. (In Italian)

In more than 4,000 examinations the author found 23 cases of transpyloric prolapse, of which 14 were adequate for publication. This incidence is below that of many other authors. In the present series, 70 per cent of the patients were males. The clinical picture is variable, and ulcer or gallbladder disease is usually suspected. The following symptom complex, however, is believed to be characteristic: epigastric pain two hours after meals, with nausea, pyrosis, and rarely vomiting. Meteorism is frequent. Weight loss, complete remission of pain and the seasonal reactivation so typical of duodenal ulcer are not observed. The incidence of antral gastritis is increased.

The pyloric canal rarely is elongated but not widened. The prolapse is usually circular and central, but is often unilateral. It is best demonstrated with the patient prone. The picture varies during the examination. There is no delay in emptying as a rule.

The author believes that a probable congenital alteration with abnormal laxity of the mucosa upon its substrate is of etiological importance. The accentuation of peristalsis is a result of and not a cause of the prolapse of the mucosa. Inflammatory changes are also important.

[For a different view of this problem which seems to be rapidly gaining ground, the reader is referred to Pohlandt, K.: Fortschr. a. d. Geb. d. Röntgenstrahlen **82**: 445, 1955.—C.V.C.]

Fourteen illustrations.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Manifestations of Hodgkin's Disease of the Gastrointestinal Tract. U. V. Portmann, E. F. Dunne, and J. B. Hazard. Am. J. Roentgenol. **72**: 772–787, November 1954.

Hodgkin's disease may first be manifested in the gastrointestinal tract. Eight cases are recorded. The lesion appeared primarily in the stomach in 6, in the jejunum in 1, and in the ileocecal region in 1.

Hodgkin's disease of the stomach produces symptoms suggesting ulcer or carcinoma. Roentgenologically, the lesion simulates carcinoma so closely that a differential diagnosis is often impossible. The infiltrating type, however, differs in three respects from infiltrating carcinoma: (*a*) Peristalsis, though sluggish, is often preserved. (*b*) There is less tendency to produce a fixed narrowing of the lumen. (*c*) Nodularity or polypoid changes in the mucosa in the involved region occur much more frequently.

Small intestinal lesions manifest themselves clinically by such non-specific symptoms as abdominal pain, diarrhea, vomiting, and distention. Most lesions are found in the jejunum or proximal ileum. The terminal ileum is the next most common site, followed by the duodenum and the remainder of the small bowel. Acute and chronic obstruction are fairly common. On the roentgen study, no specific features are demonstrated. The more localized lesions will probably be diagnosed as carcinoma or lymphosarcoma; the more diffuse lesions

as regional ileitis. The possibility of Hodgkin's disease will be considered when there is associated involvement of the superficial lymph nodes.

With the exception of the esophagus, the colon is the most infrequent site of solitary Hodgkin's lesions. Lesions of the cecum or ileum and cecum are apt to be confused clinically with appendicitis, and roentgenologically with carcinoma, tuberculosis, or other inflammatory conditions. The diffuse lesions resemble ulcerative colitis.

Resection with postoperative roentgen therapy appears to be the treatment of choice.

Eight roentgenograms; 5 photographs; 7 tables.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Calcification Within the Stomach Wall in Gastric Malignancy. Case Report and Review of Literature. Lawrence E. Batlan. Am. J. Roentgenol. **72**: 788–794, November 1954.

During the course of a gastrointestinal series in whic an extensively infiltrative carcinoma of the stomac was diagnosed, a large calcified mass was seen adjacent to the lesser curvature. It seemed to be posterior to the barium-filled gastric lumen. The calcifications were of a miliary punctate type, homogeneously distributed. Whether the calcified mass invaded the stomach, extended from it, or was separated from it could not be determined with certainty. Elsewhere it had been diagnosed as pancreatic calcification. The pathologic report on the excised stomach indicated mucinous adenocarcinoma with extension into the serosa, lymphatics, and fat. Scattered through the specimen were deposits of calcium.

Only 7 other reported cases of calcification in a gastric neoplasm were found in the literature, of which 5 were proved. All of the proved cases were characterized by the presence of mucinous degeneration. The author, therefore, speculates on the possibility that mucin, "because of some innate property of calcifiability," may have been the determining factor in calcification in his case.

Three roentgenograms; 2 photomicrographs; 1 photograph.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Some Radiological Aspects of the Resected Stomach. B. Thommen. Radiol. clin. **23**: 339–342, November 1954. (In French)

The author presents 2 cases with interesting radiologic findings after gastrectomy. In the first there were two outpouchings, one on the lesser curvature and one on the greater curvature, just proximal to the anastomosis. Preoperatively these were called ulcers, but exploration showed them to be simple deformities caused by traction from adhesions. Radiologic study of the second patient showed a large accumulation of barium near the operative stoma, which was not tender and contained air when the patient was upright. Clinical examination disclosed no tenderness in this region. This rounded accumulation of barium was thought to represent a diverticulum and exploration was not considered necessary.

The author urges care in the radiologic diagnosis of marginal ulcers.

Four roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Retrograde Intussusception at the Gastrojejunal Stoma: Two Cases and a Bibliography. Eddy D. Palmer. Am. J. Digest. Dis. **21**: 309–313, November 1954.

Jejunogastric intussusception occurs in two clinical forms. In the acute obstructive form there are severe cramping pain and vomiting, with distention, tenderness, and sometimes a palpable tumor localized over the stomach. Hematemesis may occur, or there may be severe hemorrhage, with shock. Death may result from obstruction, hemorrhage, or gangrene unless prompt diagnosis leads to surgical interference. Chronic recurring intussusception does not give a characteristic picture. Episodes of intermittent partial obstruction or brief periods of complete obstruction may mark the course of this disease. The only complaints ordinarily are vomiting and epigastric discomfort. Hematemesis may occur, but frank hemorrhage is rare.

Retrograde intussusception of the jejunum into the stomach may follow simple gastrojejunostomy or subtotal gastrectomy. The radiographic picture is characteristic in about 85 per cent of the cases, showing the typical striated appearance of jejunal segments within the stomach. In 15 per cent of the cases, the radiologist can do no more than record stomal obstruction. Surgical reduction is not necessarily required, as the condition is not invariably recurrent.

Two cases are reported.

Two roentgenograms; 2 drawings.

DONALD DE F. BAUER, M.D.
Coos Bay, Ore.

Peptic Ulcer in Children. Leslie L. Lemak, Palmer E. Wigby, and John E. Martin. Texas State J. Med. **50**: 772–775, November 1954.

The authors report 6 cases of peptic ulcer occurring in children of seven to twelve years. All the ulcers were diagnosed roentgenographically; none was proved pathologically. Follow-up roentgen studies in 2 of the children demonstrated healing in 1 and persistence of the crater in the other. Both of these patients were girls who on initial examination were nervous and irritable. One showed a favorable change in personality at the time of the second visit, when the ulcer was no longer visible; the other showed no change either in respect to personality or ulcer.

Attention is drawn to the observation that gastric ulcer is much commoner than duodenal ulcer in infants, whereas in children over two years of age duodenal lesions predominate in a ratio of 3 or 5 to 1. All six ulcers in this series were duodenal. Both the symptomatology and the roentgen appearance of ulcers in children are less distinct than in adults. The authors have found spot films very helpful in the demonstration of these lesions.

Thirteen roentgenograms.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Pathogenetic Study of a Duodenal Diverticulum in an Unusual Location. F. Gudjons. Fortschr. a. d. Geb. d. Röntgenstrahlen **81**: 655–658, November 1954. (In German)

A patient, aged 62, gave a history of dyspepsia and nausea for twenty years and of vomiting after meals, anacidity, and weight loss for the past six months

Roentgen examination revealed a large diverticulum of the superior flexure of the duodenum with a three-hour residue. At operation the diverticulum was found to be in cranio-dorsal location. It was in close contact with the head of the pancreas and was bound by dense adhesions, so that it could not be removed. A side-tracking subtotal gastrectomy was therefore performed.

On the twelfth postoperative day the patient died suddenly from pulmonary embolism. At autopsy the surgical findings were confirmed. Of special interest was a striking anomaly of the liver. Its left lobe was as prominent as the right, and the two were almost completely separated by a deep fissure which formed the base of the falciform ligament.

So-called acquired diverticula are relatively small and usually involve the descending duodenum. The size of the diverticulum in this case, its unusual location behind the proximal duodenum, and the associated malformation of the liver suggest a congenital nature.

In early embryonic life the liver is a symmetrically shaped organ having two lobes of equal size. Only at a later phase of development does a more rapid growth of the right lobe cause asymmetry. The author believes that in this instance a so-called duplication of the liver persisted from an early embryonic stage, together with a second common bile duct. This duct was probably rudimentary but could have given rise to an isolated branching of the duodenum which later developed into the atypically located diverticulum.

One roentgenogram; 1 photograph.

ERNEST KRAFT, M.D.
Newington, Conn.

Duodenorenal Fistula: A Complication of Peptic Ulceration. Francis E. Stock. Brit. J. Surg. **42:** 330–331, November 1954.

A 22-year-old man gave a history of pain in the right loin for two years. In the past two months this had increased in severity, and there were dysuria and frequency. Intravenous pyelography showed some distortion of the right upper calyx and non-filling of the right renal pelvis. A right retrograde pyelogram demonstrated a fistula between the renal pelvis and duodenal bulb. At operation, a deeply penetrating peptic ulcer was found between the posterior wall of the distal duodenal bulb and the right renal pelvis. Treatment consisted of closure of the ulcer, nephrectomy, and later gastroenterostomy. The patient was symptom-free two months later.

Three roentgenograms. J. W. BARBER, M.D.
Cheyenne, Wyo.

Rate of Absorption of Water from Stomach and Small Bowel of Human Beings. John F. Scholer and Charles F. Code. Gastroenterology **27:** 565–577, November 1954.

The two objectives of the study reported here were: (1) to develop a method whereby the actual absorption of a specific sample of water could be measured and (2) to compare the rate of absorption from the stomach and small bowel in healthy persons. Isotopic, heavy water (D_2O) was given in quantities of approximately 50 gm. intravenously, by mouth, or through a tube into the stomach or upper part of the small bowel. Arterial samples of blood were drawn each minute for twelve minutes, then at three-minute intervals for thirty minutes, and thereafter every six minutes for sixty minutes or more. The blood was obtained through an indwelling needle placed in either radial artery. The final D_2O "equilibrium" value was determined on a sample of venous blood drawn three or more hours after the administration of the heavy water. Throughout the study, the concentration of D_2O in the plasma was determined by a simplification of the mass-spectrometric method described by Solomon *et al.* (J. Clin. Investigation **29:** 1311, 1950). In most of the tests, barium was suspended in D_2O so that its position in the gastrointestinal tract during absorption could be determined fluoroscopically and by roentgenograms. Throughout all of the tests the subjects rested quietly in the supine position on a flat table.

The serial roentgenograms on 5 of the subjects in whom the water was placed in the stomach all showed that the water, or at least the barium suspended in the water, remained pooled or "puddled" in the upper portion of the stomach for periods of thirty to sixty minutes. In each of the tests this was long enough to allow for the absorption of most of the water. If the subject rolled on the right side, some of the barium promptly left the stomach and appeared in the small bowel, and this was accompanied by a change in the rate of absorption. When barium was added to the water placed in the small bowel, the material did not remain puddled at any one site but was quickly dispersed throughout a wide area in the bowel.

The mean initial rate of absorption of water from the stomach of 8 healthy persons was 2.5 per cent, per minute, of that administered. The mean time required for the absorption of 67 per cent and 95 per cent of that administered was 34.2 minutes and 54.2 minutes, respectively. The rate of absorption of water from the small bowel of 15 healthy persons was consistently much faster than that from the stomach. The mean initial rate of absorption was 26.1 per cent, per minute, of that administered. The mean time required for the absorption of 67 per cent and 95 per cent was 3.7 minutes and 10.0 minutes, respectively.

Three roentgenograms; 7 charts.

WYNTON H. CARROLL, M.D.
Shreveport, La.

Detection of Small Lesions of the Large Bowel. Barium Enema versus Double Contrast. J. Maurice Robinson. California Med. **81:** 321–324, November 1954.

The author describes in detail his technic for detection of small lesions of the colon. He feels that the single-contrast barium enema with some modifications is superior to the double-contrast study as the primary means of demonstrating polyps as well as other lesions. His method combines fluoroscopy, high-kilovoltage (preferably over 100 kv) radiography, fluoroscopically aimed spot-films taken with compression, suction and evacuation studies. Particular attention is directed to the distal third of the large bowel, where polyps are most likely to be found.

The double-contrast study is recognized as a valuable supplement to the modified single-contrast barium enema examination, but is thought not to have been sufficiently perfected to replace the latter as a primary procedure. In many cases a combination of methods will be required. THEODORE E. KEATS, M.D.
University of California, S. F.

Diverticulitis and Carcinoma of the Colon. Differential Diagnosis. Bentley P. Colcock and Robert E. Sass. Surg., Gynec. & Obst. **99**: 627–633, November 1954.

The differential diagnosis between carcinoma and diverticulitis of the colon, although at times quite difficult, is of definite practical value to the surgeon called upon to operate in these cases.

In diagnosing lesions beyond the reach of the examining finger and proctoscope, an error of approximately 25 per cent exists. Hoping to reduce this figure, the authors compared the clinical records of 50 patients with proved diverticulitis with those of 50 patients having carcinoma of the sigmoid or rectosigmoid. Patients in whom a diagnosis by digital or proctoscopic examination could be made were excluded.

The radiologist was unable to distinguish between carcinoma and diverticulitis in 16 per cent of the cases of proved diverticulitis, while he failed to make the distinction in 4 per cent of the patients with carcinoma. Seven patients with diverticulitis showed signs of perforation or fistula formation on the barium enema examination, whereas none of the patients having carcinoma gave evidence of perforation.

Malignant lesions were characterized by sharply demarcated defects with loss of the mucosal markings and lipping of the edges. Longer defects with mucosal markings and evidences of spasm and irritability were indicative of diverticulitis. Nine patients having carcinoma also showed evidence of diverticulitis roentgenographically. Five patients with diverticulitis and 1 with carcinoma had complete obstruction. Hence the length of the lesion could not be determined.

In the remaining group of patients in whom a diagnosis could not be made by means of the barium enema examination, a careful review of the history was helpful in establishing a presumptive diagnosis, either of carcinoma or diverticulitis. Thus it was found that abdominal pain had a significantly higher incidence in diverticulitis, as did also nausea, vomiting, chills, and fever. Rectal bleeding was much more frequently found in carcinoma. The same was true of constipation.

Laboratory findings were of little help in the differential diagnosis, and the incidence of abdominal or pelvic masses was the same in both groups.

Four roentgenograms; 3 tables.

DAVID J. STEPHENSON, M.D.
University of Pennsylvania

Extrinsic Deformities of the Colon Mimicking Carcinoma. A Report of Three Cases. Robert C. Overton, Billy F. Bolton, and Francis C. Usher. Surgery **36**: 906–915, November 1954.

Three unusual cases of large bowel constriction due to extrinsic lesions mimicking carcinoma are here reported. In each case, the clinical picture and roentgenographic findings were suggestive of a malignant tumor. In 2 the suspected deformities were due to adherence of an epiploic appendix across the transverse colon to the gastrocolic ligament. The third case showed a band of fibrous adhesions encircling the mobile right colon and ileum.

A barium enema in one case revealed an annular ring constricting the colon and there was difficulty in forcing barium proximal to the lesion. In another case the epiploic appendix produced a defect which had the appearance of a sessile lesion projecting into the bowel lumen, with a possible ulcer crater in its center. In the third patient the fibrous ring caused a filling defect with narrowing of the transverse colon and partial obstruction to the flow of barium. A repeat examination was reported as showing a polypoid mass, "probably carcinoma," in the colon.

More common causes of colon deformities which may simulate carcinoma are diaphragmatic and intra-abdominal hernias, large bowel spasm, residua of previous inflammation, retroperitoneal and intra-abdominal masses, congenital webs and bands.

Five roentgenograms; 2 drawings; 1 photograph.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Volvulus of the Caecum. Thomas F. Rose. Australian & New Zealand J. Surg. **24**: 125–130, November 1954.

Volvulus of the cecum is an uncommon condition, its incidence being less than 1 per cent in any large series of acute intestinal obstruction, with something over 300 cases appearing in the surgical literature. It can occur only when the primitive mesentery of the cecum persists, but this is merely a predisposing factor. In most cases, no exciting cause can be recognized.

This article contains abstracts of 5 cases of cecal volvulus in patients of sixty-two, forty-three, fifty, seventy, and sixty-three years, though most authors state that the condition occurs in young adults. The symptoms depend on the speed of formation of the volvulus and the condition of the mesenteric vessels. Slowly forming volvulus causes mild symptoms initially, whereas with rapid development symptoms are severe from the start. As in all cases of mechanical intestinal obstruction, pain is the first symptom. Constipation also occurs, and in 1 of the author's cases rather profuse diarrhea followed the subsidence of pain, obviously due to discharge of the cecal contents into the colon by spontaneous untwisting of the volvulus. The early reflex vomiting seen in acute volvulus of the small bowel is seldom observed in cecal volvulus. A radiograph of the abdomen will clinch the diagnosis by showing the long fluid level of the dilated cecum. Should this be in the left upper abdominal quadrant, it may appear at first sight to be stomach, but aspiration of that organ will rapidly solve the problem.

Treatment is immediate laparotomy to untwist the volvulus. Should the bowel be non-viable, resection must be done. The reported mortality of the condition is high, death usually being due to peritonitis following rupture of the gangrenous bowel.

Two roentgenograms.

WYNTON H. CARROLL, M.D.
Shreveport, La.

Microcolon and Meconium Ileus. G. Candardjis and F. Saegesser. Radiol. clin. **23**: 342–347, November 1954. (In French)

The basic fault in pancreatic fibrosis is the production of an abnormally viscid mucus, both in the pancreas and other organs. It has been suggested that this mucus contains an abnormal protein which, when combined with certain intestinal lipids in the presence of water, leads to the formation of a homogeneous gel that adheres to the bowel walls, producing an obstruction, situated generally between the middle of the ileum and proximal colon. This is a serious complication. If

the infant survives the ileus, he is likely to experience other difficulties in intestinal resorption.

Radiographically the obstruction from meconium ileus may resemble any other type or there may be a characteristic mottled appearance along a segment of intestine due to the mixture of gas and inspissated meconium. In addition, there is a high frequency of combined lesions, such as meconium ileus with volvulus, atresia, or an abnormal insertion of the mesentery. Intraperitoneal calcifications can appear probably within twenty-four hours after the development of peritonitis.

The authors present a case of meconium ileus in which a barium enema study showed an abnormally small colon, with a more normal appearance following operation.

While there is a true organic microcolon, usually in the form of a solid cord, such an anomaly is rare. The appearance of a small colon should usually be taken as a sign of an abnormal functional state of the colon owing to an obstruction above it. This obstruction can be the result of either atresia or meconium ileus. The diagnosis of microcolon, therefore, should be considered an operative indication.

Three roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Fistulous Imperforate Anus. Peter Ilbery. M. J. Australia **2**: 737–739, Nov. 6, 1954.

Imperforate anus and the fistulas associated with it are anomalies that may occur in the embryo between the fifth and tenth weeks of intrauterine life. It is suggested that, excluding the stenotic cases and perhaps the membranous forms, cases of imperforate anus where the terminal part of the gut is separated by an appreciable distance from the proctodeum occur as a result of fistula formation. The gut, once having found an aberrant opening to the exterior, has no stimulus to open normally. Fistulas were proved to be present, however, in only 35 per cent (12 of 35 cases). In the remainder the fistula either may have closed prior to birth or remained as a fibrous communication. The associated frank fistulas may be classified into three groups on embryonic grounds: the rectovesical and recto-urethral; the rectovaginal; and the recto-fossa navicularis and rectoperineal. Presented in detail is an extremely rare case of rectoperineal fistula occurring far anteriorly, opening through the scrotum.

Fortunately for the repair of these anomalies, the end sphincter is normally developed as it arises in connection with the perineum rather than the bowel. Of value to the surgeon is radiographic demonstration of the distance of the uppermost gas bubble from an anal marker, with the infant inverted. Three points of importance are mentioned (1) The anal marker should be firmly in contact with the anal dimple. (2) The infant should be inverted for several minutes, since the author has seen an air bubble approach from over 3/4 to 1/2 inch after five minutes of inversion. (3) The procedure is not feasible until twelve hours after birth, *i.e.*, until gas has reached the large bowel. Associated deformities are commonly present, and evidence should be sought of anomalies of the sacrum and hemivertebrae.

Two roentgenograms; 1 photograph; 1 tables.

C. M. GREENWALD, M.D.
Cleveland Clinic

One Hundred Seventeen Cases Examined by Intravenous Cholecystocholangiography. A. Maléki. J. de radiol. et d'électrol. **35**: 833–837, 1954. (In French)

In some instances normal gallbladders are not opacified on routine oral cholecystography. Such failure may be attributable to pyloric obstruction, poor intestinal absorption, impaired hepatic function, improper technic, emesis, or diarrhea. In other cases postcholecystectomy symptoms indicate a study of the biliary ducts. The author has studied 117 such subjects by means of intravenous cholecystocholangiography with Biligrafin (sold under the trade name of Cholografin in the United States).

The patient is given an enema the evening before examination and presents himself for the roentgen study in the fasting state. Two ampules of Biligrafin (each containing 20 c.c.) are injected over a ten-minute period into one of the antecubital veins. Usually films are taken ten, twenty-five, sixty, and one-hundred and twenty minutes following injection. Technical factors are 50 kv and 350 mas, with mobile grid. The films are taken with the patient upright, supine, and prone for study of the gallbladder, with a 25° left anterior oblique view for study of the biliary canals.

The hepatic ducts are usually shown in the film taken ten minutes after injection. At twenty-five minutes the common and cystic ducts are visualized. Opacification of the upper portion of the gallbladder is obtained at twenty-five minutes, sometimes showing a horizontal level between opacified and non-opacified bile when the patient is erect. Within two hours the opacification of the gallbladder is complete. Evacuation of the gallbladder may be seen following the usual fatty meal. The opaque substance is excreted in the stool without the cycle of entero-hepatic reabsorption and secretion. If hepatic function is impaired, renal excretion is predominant.

If stones are present in the gallbladder, filling defects are seen. In patients who have undergone cholecystectomy, gallstones or other obstructing factors may be demonstrated in the biliary ducts.

Contraindications include sensitivity to iodine and impaired hepatic function, especially if accompanied by impaired renal function.

Twelve roentgenograms.

CHARLES M. NICE, JR., M.D.
University of Minnesota

HERNIA

Differential Diagnosis of Hiatus Hernia: Recurrent Thromboses as Symptom of Hiatus Hernia. T. Wegmann. Schweiz. med. Wchnschr. **84**: 1292–1294, Nov. 13, 1954. (In German)

A 58-year-old woman gave a history of thrombophlebitis occurring at the age of fourteen following operation for appendicitis and again after the birth of her third child. After twenty years without any further episodes of this kind, she was hospitalized for symptoms suggesting a myocardial infarct, and at that time phlebitis occurred in all four extremities, without any known cause. The condition regressed only temporarily despite energetic treatment which included the latest and most modern anticoagulants. The blood picture was entirely normal (including the platelet count) except for a low iron level of 50 gamma per cent. The stools were free of blood.

Finally a roentgen study revealed a hiatus hernia with

reflux esophagitis. A transthoracic operation was done, with closure of the hiatus, and all symptoms ceased. There was not even a postoperative thrombophlebitis.

The correct diagnosis was suggested by a report by Lian, Siguier, and Welti (Presse méd. **61**: 145, 1953) of a definite association of recurrent thromboses with hiatus hernia.

Two roentgenograms; 3 electrocardiograms.

GERHART S. SCHWARZ, M.D.
New York, N. Y.

THE MUSCULOSKELETAL SYSTEM

Acromegaly. J. M. Finlay and R. Ian Macdonald. Canad. M. A. J. **71**: 345–353, October 1954.

This paper is a review of the clinical, radiological, and endocrinological features of 12 cases of acromegaly treated in the past six years. In 4 instances autopsy reports were available. In these 4 cases death was due to hemorrhage from a gastric ulcer, carcinoma of the colon, acute small bowel obstruction, and acute myocardial infarction.

Acromegalic facies and enlargement of the extremities were the commonest initial manifestations of the condition. Headache, fatigue, loss of libido, arthralgia, and back pain were frequent complaints. All patients showed enlargement of the jaw, ranging from early mandibular prominence to pronounced prognathism with spacing of the teeth, malocclusion, and an increased ramus-body mandibular angle. Overgrowth of bone and subcutaneous tissue had resulted in square, broadened hands in 10 patients. Thoracic kyphosis was present in 4 patients, and lumbar kyphosis in 1.

A generalized overgrowth of bone, characterized by cortical thickening with circumferential increase and coarsening of structure, was observed radiologically in the majority of the patients. Irregular ossification at the sites of muscle and ligamentous attachments, and calcification extending into the tendons and ligaments, lent a coarse, massive roughened appearance to most affected bone. The radiological features are listed in detail in table form.

In 9 patients, the sella was larger than normal, in 2 it was normal, and in 1 it was much smaller than normal.

The frontal sinuses were commonly enlarged. Serial radiography revealed that frontal sinus enlargement occurred by lengthening and convex bulging of the anterior wall with expansion in superior and lateral directions. Accentuation of the external skull markings and thickening of the calvarium to as much as 12 mm. was a common finding. Other interesting skull changes included elongation and segmentation of the styloid processes, calcification of the stylohyoid and thyrohyoid ligaments, and more extensive pneumatization of the mastoids, the cells being larger than normal.

Widening of the vertebral bodies, most evident in the low dorsal vertebrae, was present in 50 per cent of the series. Anterior and lateral accretions of new bone, demarcated from the original vertebral body by indentations at the anterior limit of the superior and inferior epiphyseal plates, were responsible for the widening. These measured as much as 6 mm. in thickness.

Fusiform widening of the ribs at the costochondral junction was present in half the patients and produced a palpable step-like deformity at that site in at least 2 cases. Enlargement of the medial ends of the clavicles was also noted.

Circumferential overgrowth of the heads of some metatarsals and metacarpals resulted in an appearance of "mushrooming" of the shafts into the heads of the bones. Degenerative joint changes and loose body formation were frequent. Ossification of tendons and ligaments was noted also in the extremities.

The widening of vertebral bodies and fusiform enlargement at the costochondral junction of the ribs are said to be late and specific radiological features of acromegaly. The costochondral enlargement has been designated as the "acromegalic rosary." The accretion of new bone on the vertebral bodies appears to be due to periosteal apposition of bone rather than ossification of the anterior common ligament, for it is confined to the exact height of the vertebrae and does not extend into the anterior common ligament opposite the disk space.

The phalanges and metacarpals or metatarsals have seven articular sites for longitudinal growth, while the humerus or femur have only two; thus greatest overgrowth occurs in the hands and feet. The only site for longitudinal growth of ribs is at the costochondral junction; hence the distortion of rib shape and shape of the thoracic cage. In the skull, surface apposition of bone appears to occur more readily in the masticatory skeleton than in the neurocranium. The growth of the mandible is said to be secondary to endochondral ossification at the head of the condyle, surface apposition of bone in certain areas, and bone resorption in others. Spacing of the teeth is secondary to mechanical forces.

Frequent periodic examination in suspected cases may reveal bone changes, enlargement of the sella, or change in body configuration, and thus establish the diagnosis.

X-ray therapy is indicated in all early cases with an established diagnosis, in all advanced cases showing signs of reactivation, progressive visual field defect or intractable headache, and postoperatively in all patients who have undergone removal of a pituitary tumor. Deep x-ray therapy was given to 6 of the 12 patients in the present series. After irradiation 1 patient had remission of the disease and restoration of potency. In 2 cases amelioration of headache with improvement in vision occurred. No change was noted in the remaining 3 cases.

Non-specific therapy includes the use of testosterone for hypogonadism and hypopituitarism, cortisone with or without desoxycorticosterone for adrenal insufficiency, and dexedrine sulfate for lassitude. The results of such treatment are variable.

Six roentgenograms; 4 photographs; 1 graph; 4 tables.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Osteomalacia in New York. I. Snapper, R. Seely, S. Falk, and I. Feder. Ann. Int. Med. **41**: 893–909, November 1954.

Osteomalacia is a metabolic disease of bone in which insufficient amounts of calcium and/or phosphorus are available. This prevents normal calcification of bone matrix and demineralization eventually results. After a state of calcium depletion has existed for a while, a considerable proportion of the skeleton consists of osteoid. Bone pains appear, and roentgen examination of the skeletal system reveals generalized demineralization and possible pathologic fractures. Often roentgenograms disclose the presence of small fissures in the cortex of the long bones, consisting of proliferation of

osteoid which remains uncalcified, the so-called Looser's zones or Milkman's fractures. The serum calcium and phosphorus are low, reflecting the depletion of the calcium and phosphorus stores of the organism. For the same reason, practically no calcium is excreted in the urine. As the skeleton weakens, the bones are submitted to greater stress, which gives rise to an increase in osteoblastic activity. This in turn causes an increase in the serum alkaline phosphatase. It should be noted, however, that early in the course of the disease, before marked weakening of the skeleton has occurred, the alkaline phosphatase may be normal, despite altered values of serum calcium and phosphorus. In this way the general clinical and biochemical picture in rickets and osteomalacia develops.

A negative calcium balance leading to osteomalacia may come about in various ways. The most obvious cause is evidently a simple lack of vitamin D, which is the chief agent controlling the absorption of calcium from the intestine. Avitaminosis D is thought to occur only in regions where exposure to sunshine is scarce and dietary deficiency and malnutrition are common. Elsewhere osteomalacia is practically limited to conditions where the fat-soluble vitamin D is not absorbed from the intestine, as in the sprue syndrome, in chronic biliary obstruction, and in long-standing obstruction of the pancreatic ducts. In the sprue syndrome, the absorptive powers of the small intestine are impaired. In pancreatic disease, the absence of lipase prevents the hydrolysis of neutral fats which is necessary for fat absorption, and in chronic biliary obstruction the bile acids, important factors for the absorption of fats, cannot reach the lumen of the small intestine. In one of the authors' patients, sclerodermatous changes of the intestinal wall apparently prevented the absorption of fat and fat-soluble substances, among them vitamin D.

A small group of cases of osteomalacia is seen in association with the rare syndrome of renal tubular acidosis. In this renal disease, the inability of the kidney tubules to reabsorb basic radicals causes considerable loss of the fixed base of the body, including large quantities of calcium in the urine. A negative calcium balance ensues, beginning the biochemical sequence which ends in clinical osteomalacia.

Four cases seen in various hospitals in New York City illustrate the occurrence of osteomalacia in association with disturbances of the absorption of fats and fat-soluble substances from the gastrointestinal tract.

Five roentgenograms. STEPHEN N. TAGER, M.D.
Evansville, Ind.

Disappearing Bones: A Rare Form of Massive Osteolysis. Report of Two Cases, One with Autopsy Findings. L. W. Gorham, A. W. Wright, H. H. Schultz, and F. C. Maxon, Jr. Am. J. Med. **17**: 674–682, November 1954.

The complete resorption of a bone or group of bones is a rare finding. The authors report 2 cases, 1 with autopsy findings. In addition, a summary of 16 cases from the literature is given. On the basis of this material, descriptions of the clinical characteristics and pathological changes and a possible explanation for the syndrome of massive osteolysis are presented.

This unusual disease process is found predominantly in teen-age children and young adults. Osteolysis usually follows a minor traumatic incident, but there is a relatively long time interval before the bone changes ensue. The clinical course is protracted but may become completely arrested after a period of years. In only one case was the disease responsible for the patient's death (at autopsy there was an extensive phlegmonous inflammation of the soft tissues of the shoulder girdle, chest wall, and mediastinum, and the osteolytic process involved the right shoulder girdle). Clinically and radiographically, the first abnormality may register as an absence of a portion of one bone or one group of bones and this may progress to complete disappearance of an entire bone.

Pathogenetically, the process is characterized by a loss of cellular components of the marrow and replacement by a heavily vascular fibrous tissue. Concomitantly there is disintegration of both cortical and cancellous elements of bone until eventually nothing but a vascular fibrous tissue remains. Associated with this osteolysis is an inflammatory reaction in the adjacent connective tissues and nerves. Morphologically, the most striking feature is the intense hypervascularity which, in most of the cases with biopsy, led to a pathological interpretation of angiomatosis.

The authors feel that the underlying process is primarily one of capillary proliferation and active hyperemia leading to an absorption of the mineral content of the bone and eventually osteolysis, although they do not disregard the possible role of diffuse inflammation or trophic changes (due to perineural inflammation).

Two roentgenograms; 2 photomicrographs; 1 photograph. JOHN W. WILSON, M.D.
University of Texas

Osteomyelitis in the New-Born. C. M. C. Potter. J. Bone & Joint Surg. **36-B**: 578–583, November 1954.

Osteomyelitis of the long bones occurring in the neonatal period may be associated with acute septicemia or multiple bone lesions may develop while the general condition is well maintained. The source of infection is usually the skin or the umbilicus, and the common organisms are the hemolytic streptococcus and *Staphylococcus aureus*.

The author reviews the pertinent literature and reports 6 cases. Only 1 of his patients presented a serious constitutional disorder. The other 5 fitted into the "benign" grouping. In accordance with previous observations, sequestration was found to be uncommon. This may be explained by early decompression permitted by the spongy nature of the infant's bone and loose attachment of the periosteum. When sequestration does occur, it prevents the rapid healing that is usually observed after drainage of the abscesses.

The most serious complication to be anticipated is suppurative arthritis. This may lead to total destruction of a joint, as in one of the cases in this series. The author believes that a lowered mortality from infantile septicemia due to wider use of chemotherapy may lead to an increased incidence of cases of acute osteomyelitis in clinical practice.

Eleven roentgenograms. JOHN F. RIESSER, M.D.
Springfield, Ohio

The Clinical Picture of Vitamin-D-Resistant Rickets (Type "Phosphate Diabetes"). W. Swoboda and W. Rupp. Fortschr. a. d. Geb. d. Röntgenstrahlen **81**: 582–590, November 1954. (In German)

Early rickets can be divided into the ordinary type

and the so-called "phosphate diabetes" type. The latter is rare but 6 cases were seen by the authors within a period of eighteen months. It occurs at a somewhat later age than the ordinary type (six to eighteen months instead of three to six months), and develops in spite of prophylactic vitamin-D medication.

There is a characteristic familial tendency and the bowing is almost exclusively confined to the femora. There are also lumbar lordosis and coxa vara, occasionally with epiphyseolysis of the femoral head. The roentgen findings are practically identical with those in rachitis tarda. The growth is retarded and the deformities tend to increase for a long period of time in spite of ample vitamin-D intake.

In ordinary rickets the inorganic serum phosphorus is decreased, the serum calcium is normal or decreased, and the alkaline serum phosphatase is elevated. Existence of resistant rachitis or "phosphate diabetes" can be concluded when the serum phosphorus is normal or higher than would be expected in ordinary rickets and fails to increase following massive doses of vitamin D.

Daily doses of 5 to 10 mg. vitamin D have to be given for months and years. When the patients are bedridden, nephrocalcinosis may occur due to disuse. This complication can be prevented by interruption of medication during periods of immobilization. The authors recommend that orthopedic corrections be postponed until the effect of vitamin-D therapy is evident.

Ten roentgenograms; 1 photograph; 1 graph, 2 tables. ERNEST KRAFT, M.D.
Newington, Conn.

The Significance of Serum Protein Shifts in the Diagnosis of Bone Tumors. Béla Gimes and Zoltán Szendröi. Fortschr. a. d. Geb. d. Röntgenstrahlen **81:** 567–582, November 1954. (In German)

The diagnosis of bone tumors depends primarily on roentgenographic findings. Occasionally, however, it may be difficult or even impossible to differentiate between benign and malignant neoplasms and to exclude atypical osteomyelitis. In such cases the recently introduced electrophoretic tests have been of considerable aid. The authors tabulate observations on 9 benign tumors, 21 malignant tumors, and 9 cases of osteomyelitis simulating sarcoma, in which the new laboratory tests have been helpful. They arrive at the following conclusions:

(1) In benign tumors serum fractions are normal, which is important for the exclusion of giant-cell-tumors and sarcoma.

(2) In primary and metastatic malignant tumors and in inflammatory processes the A/G ratio is decreased.

(3) In plasmacytoma there is a characteristic sharp rise of the curve of all the single globulin fractions which is of importance diagnostically as well as prognostically.

(4) In primary malignant tumors without associated inflammatory changes, the alpha-2 and gamma fractions of the globulin are elevated.

(5) In metastatic lesions the A/G ratio is diminished and the alpha-2 and beta fractions are increased, even when the primary tumor has been removed and there is no local recurrence. When the primary tumor is still present and intermittent inflammations such as cystitis are noted, the characteristic electrophoretic curves are rarely altered.

(6) In chronic osteomyelitis, rendered atypical by antibiotic therapy, the gamma globulins are increased.

(7) The effect of roentgen therapy can be followed by the electrophoretic tests. As soon as a radiodermatitis occurs, a characteristic inflammatory curve is obtained, with increase of the gamma globulins.

Twelve roentgenograms; 1 photograph; 9 graphs; 3 tables. ERNEST KRAFT, M.D.
Newington, Conn.

Metaphysial Dysostosis. Report of a Case. J. A. P. Cameron, W. B. Young, and H. A. Sissons. J. Bone & Joint Surg. **36-B:** 622–629, November 1954.

A Chinese boy of 7 years was seen on account of deformities of the upper and lower extremities and the chest, first noticed at about twenty months of age. The head was slightly enlarged. Ribs showed a "rosary" at the costochondral junctions. The ends of all long bones were enlarged and deformed.

Radiographically the disorder appeared to be restricted to the metaphyseal side of the growth cartilage and in the long bones extended into the adjacent terminal spongiosa. In the flat bones of the pelvis and shoulder girdle the maximum change was about the acetabulum, sacroiliac joints, iliac crest, and glenoid. Epiphyseal bone centers were not affected. The shafts of the long bone were relatively unaffected, but the ends were expanded and cupped. The walls of the cup were formed of sclerotic, thickened bone and in some areas were fragmented. The bottom of the cup consisted of a zone of dense irregular interlacing trabeculae. The expanded ends of the bones appeared to contain a material of soft-tissue density with scattered fragments of dense bone. Changes at the anterior ends of the ribs were similar.

There was retardation of bone development, bone age being computed at two and a half years. This suggested a probable normal development up to the latter age, with subsequent disordered endochondral bone growth.

Biochemical determinations failed to indicate any evidence of renal osteodystrophy such as that described in a similar case by Müller and Sissons (J. Bone & Joint Surg. **33-B:** 231, 1951. Abst. in Radiology **58:** 613, 1952). The abnormality here is considered an example of "metaphyseal dysostosis," an entity separate from other chondrodystrophies.

Six roentgenograms, 5 photographs; 3 photomicrographs. JOHN F. RIESSER, M.D.
Springfield, Ohio

Experimental Study of Effect of Pressure on Healing of Bone. Lee T. Ford and J. Albert Key. Arch. Surg. **69:** 627–634, November 1954.

Clinical experience has shown that the use of "positive pressure" is followed by union of cancellous bone in a shorter time than mere approximation of the fragments. This study is an attempt to determine how important pressure is to the healing of bone, other features being equal.

Operations were carried out on iliac bones (bilateral) of 19 dogs. Rates of healing of saw cuts were compared when fragments were subjected to heavy pressure, light pressure, and distraction. Five to six cuts, 0.5 mm. wide, were made at right angles to the crest of the ilium, through the entire thickness of the bone. Small nails (1.3 cm. long) were driven into bone at right angles to

the crest and at equal distance from the saw cuts. A small rubber band (orthodontic band) was looped back and forth over the two distal nails so that 8 to 12 strands exerted heavy pressure on the intervening saw cut. A similar band was doubly looped over the remaining two nails, applying a light pressure to the intervening saw cut. The center saw cut between the two pairs of nails was then distracted slightly by virtue of the rubber band and nail arrangement on either side. Cuts outside of the nail area served as controls. At intervals varying from one to twelve weeks, the dogs were killed, the ilium was dissected out and examined radiographically and pathologically.

After seven to ten days the cuts in the bone were all visible but no motion on either side of the two pressure cuts could be demonstrated. A slight springy motion was present in the control cut and in the distraction cut. At seventeen days slight motion was demonstrated in the distraction cut; at twenty days and thereafter, all cuts were solidly healed by bone.

Microscopic sections showed osteoid and early appositional bone in all cuts at one week. At two weeks, the new bone in the cancellous region was more mature and appositional bone trabeculae had begun to fill in the gap between the cut ends of the cortex. At the end of three weeks a notch filled with soft tissue was present at the surface of the distraction cut and the new bone below this was less dense than in the pressure cuts. In specimens removed after three weeks, the trabeculae bridging the cuts was relatively mature dense bone.

The authors conclude that experimental fractures of bone which is largely cancellous and with a good blood supply show early bone union when immobilized in reasonably good apposition; additional positive pressure does not seem to have any marked influence on the rate or manner in which healing occurs; excessive pressure did not cause necrosis and non-union. It is felt that there was significantly little difference in the rate or manner in which the various cuts healed.

Five roentgenograms; 1 photograph.

F. F. RUZICKA, JR., M.D.
St. Vincent's Hospital, N. Y.

Thoracic Outlet Syndrome; Case Associated with Short "First" Rib, Aneurysm of the Subclavian Artery and Occlusion of Brachial Artery. J. R. E. Fraser and A. J. Barnett. M. J. Australia **2**: 739–743, Nov. 6, 1954.

The first known and most widely recognized structural abnormality in the region of the thoracic outlet, associated with vascular symptoms, is the cervical rib. Only later was it recognized that pressure by either a normal or an abnormal first thoracic rib could play a similar role. The scalenus anterior muscle has also been mentioned as of significance in the mechanism of vascular compression. Overaction of the muscle may be the primary fault, in the absence of rib abnormality.

Symptoms in the thoracic outlet syndrome are usually divided into vascular and nervous, these features often occurring separately. There is increasing evidence that vascular symptoms may be due to a direct arterial effect with thrombosis and embolism, rather than to sympathetic nervous irritation.

A carefully documented case of subclavian aneurysm with a short first rib is reported. Roentgen examination revealed 13 ribs on each side. The first of those on the left was directed more laterally than on the right. It was unusually short and ended proximal to the expected point of crossing of the clavicle and first rib. The anterior end of the second rib on each side was directed toward the normal point of insertion of the costal cartilage of the first rib in the sternum. It was shown at operation that the subclavian artery was compressed by the scalenus anterior muscle; this was not due to spasm but resulted from the proximity of its insertion to that of the scalenus medius, owing to shortness of the first rib. There was aneurysmal dilatation of the third portion of the artery distal to the compressed region. Similar post-stenotic dilatation can be seen in coarctation of the aorta and in pulmonary stenosis. It is suggested that dilatation is due to disruption of elastic tissue by rapidly changing pressures occurring in turbulent flow. Although the average pressure distally is reduced, it has been shown that there may be tremendous instantaneous pressures.

In this case there was a history of repeated occlusions: first of the vessels of the hand, then of the radial artery, and finally of the lower part of the brachial artery. At operation the scalene muscles and the first rib were divided, resulting in postoperative improvement in the hand. The aneurysm was found to contain a clot, supporting the view that vascular disturbance due to thoracic outlet abnormality may be embolic. No evidence of involvement of nerves was demonstrated.

Two roentgenograms; 1 photograph; 2 drawings.

C. M. GREENWALD, M.D.
Cleveland Clinic

A Study of the Function of the Cervical Spine in Dorsal and Ventral Flexion. D. Albers. Fortschr. a. d. Geb. d. Röntgenstrahlen **81**: 606–615, November 1954. (In German)

In a series of 1,100 cases, three different types of cervical spine could be recognized on the lateral views. Slight lordosis was found in 41 per cent, moderate lordosis in 10 per cent, and absence of a curve in 49 per cent. A straight cervical spine was often entirely within normal limits and did not imply disease.

The extent of forward and backward flexion was determined in a group of 60 normal persons ranging in age from eighteen to fifty years. It was found that motion was maximal from C-3 to C-6 but was almost negligible above and below this area.

Frequently roentgen findings are entirely normal on the anteroposterior, oblique, and conventional lateral views in spite of existing symptoms. When osteoarthritis is suspected but cannot be recognized on the ordinary lateral film, additional views with extreme dorsal and ventral flexion of the head will often prove helpful. Only on these views may one observe significant anterior or posterior shifts of one or more cervical bodies and localized disk thinning, especially anteriorly. With ventral flexion of the head, one may find only a single pair of small articulations with maximal motion, while other joints above and below this area are practically motionless. This will result in a kink or posterior angulation of the spine with subluxation of the facets at the apex of the angle.

For the recognition of minimal changes, therefore, the author recommends lateral views with extreme ventral and dorsal flexion as well as with a neutral position of the head.

Ten illustrations, including 3 roentgenograms; 5 tables.

ERNEST KRAFT, M.D.
Newington, Conn.

Calcification of Intervertebral Discs in Children. C. S. Walker. J. Bone & Joint Surg. **36-B:** 601–605, November 1954.

The author reports the occurrence of calcification in the intervertebral disks of the lower thoracic and upper lumbar spine in a ten-year-old girl in association with low back and hip pain. A review of 7 previously published cases in children is included.

The patient was first seen in 1944. Radiographic examination revealed calcification in three disks, T-12, L-1, and L-2. The calcified masses appeared to be bulging laterally and posteriorly, and one was fragmented. The spine was immobilized, with the patient on a straight frame, and after three months the uppermost calcification had almost disappeared. There were no further symptoms for three years. At the end of that time examination in conjunction with new onset of pain showed fragmentation of the lowermost calcification. Four months later this calcification disappeared. Three years later, in 1950, the last of the calcifications was gone.

It is notable that, in this case, the calcified masses caused pain only when there was disintegration of the calcified zones just before absorption. There were no symptoms while the lesions were radiographically dormant.

Calcification of intervertebral disks in children, unlike the condition in adults, is a reversible process. This apparently has a relation to the blood supply of the disk in childhood. The normal adult disk is avascular, since the blood vessels present in the child show complete degeneration by the age of twenty to thirty years.

In 3 of the reported cases there were pyrexia, leukocytosis, and an elevated sedimentation rate, suggesting a possible metastatic infective basis. There was no evidence of infection in the author's patient.

Nine roentgenograms. JOHN F. RIESSER, M.D.
Springfield, Ohio

Sacralization: An Aetiological Factor in Lumbar Intervertebral Disk Lesions, and a Cause of Misleading Focal Signs. John Andrew. Brit. J. Surg. **42:** 304–311, November 1954.

The author's object in the study reported here was to compare the incidence of both frank and occult sacralization in patients suffering from lumbar disk protrusions with that in a control series and to analyze the neurological findings with reference to the level of disk protrusion. For this purpose, roentgenograms of 150 patients with protruded disks, proved at operation, were examined. The control series consisted of 150 intravenous pyelograms.

The term "occult sacralization" is used to designate an intermediary stage between a normal skeletal arrangement of the lumbosacral spine and full sacralization. This intermediary condition is characterized by a sacrum set abnormally high in the pelvis, so that the lower surface of the next to the last lumbar vertebral body is above a line drawn between the iliac crests. There are five lumbar vertebrae, but the sacrum frequently consists of six segments with five pairs of neural foramina.

Statistical analysis of the author's findings showed a definitely increased incidence of sacralization in patients suffering from verified disk protrusions. The highest percentage of protrusions occurred in the "occult sacralization" group, where 58 per cent of individuals with herniated disks showed this anomaly. In the "control" series (asymptomatic persons), 41 per cent showed "occult sacralization," serving to emphasize the common occurrence of lumbosacral anomalies of segmentation.

An analysis of neurological findings in those cases with verified disk protrusions showed the presence or absence of the ankle jerk to be the most reliable single sign. Paresthesias and sensory disturbances were frequent. The greatest number of discrepancies in neurological findings were associated with protrusions occurring at the last disk space with frank sacralization.

Six roentgenograms; 3 diagrams; 1 chart; 6 tables.
J. W. BARBER, M.D.
Cheyenne, Wyo.

Concerning the Radiolucency Lines (So-Called Vacuum Phenomenon) in the Lumbar Intervertebral Disks. H.-J. Fiebelkorn. Fortschr. a. d. Geb. d. Röntgenstrahlen **81:** 601–605, November 1954. (In German)

In a series of 1,094 examinations of the lumbar spine radiolucent lines were observed in 3.6 per cent. These changes were always associated with osteoarthritis and sometimes with an additional scoliosis. When only spines showing degenerative processes are considered, the incidence was 8.4 per cent.

Of 39 patients, averaging fifty-three years in age, 25 were females. In 33 cases, the changes were limited to a single disk and in the remaining 6 cases multiple disks were involved.

The radiolucent zones were best seen on lateral views, especially in the erect posture with exaggerated lordosis. With this technic the phenomenon could invariably be elicited in all positive cases. This observation suggests a true vacuum phenomenon, since it is doubtful that accumulation of gas could be produced without some delay. Since the involved disks always show some degeneration, the author believes that dehydration and fissure formation, occurring at an advanced age, are a sufficient explanation of the phenomenon. The action of the long dorsal muscles is believed to be adequate to separate the splintered layers of the degenerated disk.

Eight roentgenograms. ERNEST KRAFT, M.D.
Newington, Conn.

The Syndrome of Herniation of the Lower Thoracic Intervertebral Discs with Nerve Root and Spinal Cord Compression. A Presentation of Four Cases with a Review of the Literature, Methods of Diagnosis and Treatment. Joseph A. Epstein. J. Neurosurg. **11:** 525–538, November 1954.

Four cases of lower thoracic intervertebral disk herniation are presented, with a review of the literature pertaining to the diagnosis and treatment of the condition. It occurs predominantly in middle life, and trauma is of no special etiologic significance.

The author stresses particularly the occurrence of radicular pain as evidence of nerve root compression. This occurred in 3 of his cases, and was the most conspicuous and disabling symptom. Unnecessary diagnostic and surgical procedures were performed on 2 patients and were contemplated in the third. In the fourth patient, pain was completely absent, the primary alteration occurring in the spinal cord.

Plain roentgenograms of the spine were of assistance in only 1 case, revealing scoliosis and hypertrophic

osteoarthritis localized to the adjacent aspects of the eleventh and twelfth dorsal vertebrae. The findings on lumbar puncture were normal, with no evidence of block or unusual protein elevation. Clinical findings were at best suggestive, myelography establishing the diagnosis in each instance. Fluoroscopy was most important, showing the moving column of oil to halt at the level of the interspace concerned. With further tilt of the table, the Pantopaque was observed to flow around the partial block in the lateral gutter opposite the obstructing ridge. Spot films taken in lateral as well as anteroposterior projections confirmed the relation of the block to the interspace. Lateral exposure demonstrated location of the lesion anterior to the cord.

Surgical treatment is directed toward removal if the herniation or protrusion is lateral, and simple decompression with sectioning of dentates if the process is mid-line with predominant cord involvement.

Seven roentgenograms; 1 photograph.

SAIM GOKHAN, M.D.
Mercy Hospital, Pittsburgh

Complete Protrusion of a Calcified Nucleus Pulposus in the Thoracic Spine. Report of a Case. Rohan Williams. J. Bone & Joint Surg. **36-B:** 597–600, November 1954.

Calcification of the nucleus pulposus of one or more thoracic intervertebral disks is a relatively common finding. Prolapse of the nucleus is, however, distinctly uncommon.

The case reported by the author presents some interesting features. The patient, a married woman of 47 years, was first seen because of pain in the region of the left lower costal margin and lower sternum. Film study revealed the presence of rather marked calcification of the nucleus pulposus between T-10 and T-11. The calcified nucleus measured 21 × 24 × 7 mm. and was associated with an anterior calcification at the same level, apparently in the annulus fibrosus.

Approximately two months later, upon admission for severe back pain, radiographic examination, including tomography, showed that the whole of the calcified nucleus pulposus had been extruded posteriorly and was lying behind the upper part of the body of T-11, apparently intact. The disk space had become appreciably narrowed. The postero-superior margin of the body of T-11 was defective, as if a marginal avulsion had occurred with the disk rupture and protrusion. In a few days symptoms had subsided.

It is possible that, without knowledge of the previous appearance, the findings on the second examination could have been misinterpreted as indicative of a mixed osteolytic and osteosclerotic inflammatory or neoplastic lesion of T-11. Review of the lateral films suggests that pressure on the spinal cord was relieved by the "avulsion" or "giving-way" of the postero-superior margin of the body of T-11 coincident with the protrusion of the disk and explains why symptoms subsided and there was no development of neurological signs.

Four roentgenograms. JOHN F. RIESSER, M.D.
Springfield, Ohio

Localised Osteochondritis of the Lumbar Spine. Douglas W. Lamb. J. Bone & Joint Surg. **36-B:** 591–596, November 1954.

Although the clinical and radiographic picture of osteochondritis of the thoracic spine, termed Scheuermann's disease, is widely recognized, there has been little reference in the literature to a similar affection involving localized areas of the lumbar spine and producing a characteristic defect of the vertebral body. The author presents 7 case reports illustrating the occurrence of such a condition in the juvenile patient.

All the patients complained of pain, 6 in the lumbar spine and the other in the region of the hip; in 3 there was considerable paravertebral muscle spasm with limitation of movement. Radiographs revealed a typical defect in each case: narrowing of a disk space with a characteristic "punched-out" defect of the upper or lower anterior corners of the adjacent vertebral bodies. In some there was an associated central disk protrusion.

This condition must be distinguished from tuberculous spondylitis. In the present series, although there was no clinical or other radiographic evidence of tuberculosis, all the lesions had been diagnosed by competent radiologists as probably tuberculous. Important differential points are a normal erythrocyte sedimentation rate; negative Mantoux test; presence of Schmorl's nodes or other radiographic evidence of vertebral epiphysitis in the thoracic spine; the punched-out appearance of the defect; absence of abscess formation.

The author feels that the condition is caused primarily by a weakness of the intervertebral disk, congenital or post-traumatic. This is suggested by the constant narrowing of the disk space, with the occasional association of Schmorl's nodes. The mechanism of production of the vertebral body lip defects may be similar to that thought to underly the production of Schmorl's nodes.

In all these cases there was a slow regeneration of the vertebral defect over a period of months, with or without restriction of activity.

Eighteen roentgenograms. JOHN F. RIESSER, M.D.
Springfield, Ohio

Bone Cysts and Osteoarthritis of the Hip. Elvio Cecchi and Aligi Fiumicelli. Radiol. med. (Milan) **40:** 1066–1071, November 1954. (In Italian)

The authors examined 100 cases of osteoarthritis of the hip, in 34 of which subchondral bone cysts were observed. The cysts were noted in early stages of the disease or in a late period when degenerative lesions were already far advanced. The cysts were evident especially in the areas of "greatest stress" except when the osteoarthritic process had already greatly altered the structure of the femoral head.

The authors believe that the subchondral cysts, characteristic of osteoarthritis, are due to a progressive widening of the bony trabeculae; this widening is produced by the "forceful injection" of synovial fluid into bony structures through linear lacerations of the articular cartilage and of the cortical bone. This pathogenetic hypothesis is proved by: (1) presence of a communication between cysts and synovial space; (2) chemical identity between synovial fluid and content of the cyst; (3) localization of the cysts in the portion of the femoral head especially vulnerable because of weight-bearing. It is also significant that no osteoclasts are identified in the wall of the cysts and that pronounced pericystic osteosclerosis is demonstrated histologically.

Two cases of acute post-traumatic cysts of probably the same pathogenesis are also reported. Clinically, pains of increasing intensity were observed and there was x-ray evidence of the disruption of the subchondral bony layer. It is possible that these cysts were pro-

duced by penetration of synovial fluid into the bone substance.

Eleven roentgenograms; 1 drawing.

R. G. OLIVETTI, M.D.
Newington, Conn.

Bone Anomalies of the Tarsus in Relation to "Peroneal Spastic Flat Foot." E. A. Jack. J. Bone & Joint Surg. **36-B:** 530–542, November 1954.

Until the publication in 1947 of work performed by Harris and Beath (Army Foot Survey: An Investigation of Foot Ailments in Canadian Soldiers. National Research Council of Canada. Report No. 1574) the cause of peroneal spasm and rigid flat foot had been poorly understood. These authors described for the first time a developmental anomaly at the sustentaculum tali, the talocalcaneal bridge, and called attention to another condition also associated with so-called spastic flat foot, previously described but unheeded, namely the calcaneonavicular bar. Webster and Roberts found one or both of these anomalies in 14 of 21 cases of peroneal spastic flatfoot (J.A.M.A. **146:** 1099, 1951. Abst. in Radiology **58:** 782, 1952), and the present author, whose work is here published posthumously, observed them in 23 of 30 cases.

The calcaneonavicular bar and the talocalcaneal bridge are similar anatomical defects with similar developmental cause. In each case the tissue uniting the two main bones may be completely osseous (synostosis), or the bone may be divided by a fissure of varying width consisting of cartilage (synchondrosis) or fibrous tissue (syndesmosis). The bony processes found vary considerably in nature and dimensions and are often as much as an inch in width.

These bone anomalies are difficult to demonstrate in routine anteroposterior and lateral films of the foot. Special (often multiple) oblique views of the foot and axial views of the heel are necessary. Spur formation on the dorsal and lateral side of the head of the talus is often found in association with the defects but is not in itself diagnostic of a tarsal anomaly since it occurs in other conditions where there has been a long standing valgus deformity at the midtarsal joint. The spurs are seldom found in patients under the age of sixteen. They tend to develop during adolescence in cases with severe persistent symptoms and in older patients with rigid eversion of the foot.

In 7 patients of the author's series there was peroneal spasm without bone anomaly. In 4 of these the spasm was related to trauma or chronic strain of ligaments; in 2 others rigid everted feet followed some years after an atrophic arthritis of the tarsus; in 1, recurrent peroneal spasm and pain were eventually found to be due to tuberculous infection of the talus.

Symptoms in the patients studied usually first appeared near the age of puberty. While the developmental anomalies undoubtedly exist from birth, the author suggests that during childhood union consists entirely of cartilage and only after ossification and consequent rigidity are established will symptoms result.

The management of a case in early adolescence is expectant and symptomatic. Rest is imposed by plaster casting. In cases of long standing, in which deformity is great or disability pronounced, fusion of subtalar and midtarsal joints has been carried out.

Seventeen roentgenograms; 3 tables.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Unidigital Clubbing, with Report of a Case. Basil A. Stoll and W. R. Beetham. M. J. Australia **2:** 852–855, Nov. 27, 1954.

The authors present a case of unidigital clubbing of apparently idiopathic development in an 11-year-old girl. This is believed to be the first such case recorded. There was no history of trauma to the finger. No abnormality in the pulmonary and cardiovascular systems or the gastrointestinal tract could be detected on clinical examination, nor was there any roentgen evidence of a parenchymatous lesion in the lungs.

The radiographic features were similar to those described by Camp and Scanlan (Radiology **50:** 581, 1948). There was soft-tissue swelling of the end of the left index finger, the distal phalanx being broader and longer than that of the right. Some sclerosis was demonstrable in the medulla, so that clear demarcation between cortex and medulla was lost. No change toward spatulation or hypertrophy of the ungual tip of the terminal phalanx was observed.

The onset at puberty in this case suggests some relationship to the group of idiopathic cases recently described in the literature, but these are said to be progressive, symmetrically involving all fingers, and associated with changes in the long bones and joints, skin changes in the face, and hormonal imbalance. The authors' case showed none of these features.

Three roentgenograms; 1 photograph.

GYNECOLOGY AND OBSTETRICS

A Simplified, Inexpensive Technique in Hysterosalpingography. Arthur J. Bendick. Surg., Gynec. & Obst. **99:** 642–646, November 1954.

In hysterosalpingography for determining the cause of sterility, Lipiodol is considered the best of the opaque media because it is the only one that can be seen several hours later in the peritoneal cavity. In studies of uterine pathology, however, the water-soluble media are preferred because of their lesser density and the fact that they do not remain in the peritoneal cavity for a long time. It is felt, also, that they give a better coating of the uterine mucosa, especially when an air contrast study is desired.

In general there are two methods of uterosalpingography. The author favors injecting the opaque material under fluoroscopic guidance, with spot-filming during the injection. The other method consists of taking Bucky films following the injection of each cubic centimeter without fluoroscopy.

The author obtains four views on a single film during the filling of the uterine cavity. Occasionally he will remove the opaque material and re-inject air for a double-contrast study. As soon as the four views are taken, one 8 × 10-inch spot film of the uterus and tubes is made, with the instruments in position and the uterine cavity filled.

The size of the uterine cavity, the exact amount of medium needed, and the patency of the tubes can all be determined immediately by the fluoroscopic method. Excessive spill into the peritoneum may also be prevented.

The author concludes with a few remarks on radiation protection in respect to the gynecologist's hands and the hazards involved.

Seventeen roentgenograms; 1 photograph.

WILLIAM H. NEIL, M.D.
University of Pennsylvania

The Value of Radiology in Antepartum Haemorrhage. John Dawson and P. R. Mitchell. Brit. M. J. **2**: 1085–1086, Nov. 6, 1954.

The placental silhouette can be demonstrated roentgenographically after the thirty-second week of gestation, at which time subcutaneous fat is deposited in the fetus.

The authors' technic for placental visualization calls for (1) lateral views of the abdomen in the recumbent position, one with sufficient penetration to visualize the posterior half of the abdomen, the other with less penetration for the anterior half; (2) a lateral study of the pelvis in the erect or semi-erect position. If the placenta is not seen on the anterior or posterior uterine wall, then it is implanted either in the pelvis (placenta praevia) or on the lateral wall (rare), and in this instance additional oblique and postero-anterior films are necessary for identification.

With placenta praevia, the presenting part is displaced out of the confines of the pelvic brim. Displacement of the presenting part alone, however, is inadequate for the diagnosis, since this may be due to other causes, such as a full bladder and rectum, a pelvic tumor, disproportion, or a short umbilical cord. It is necessary, therefore, to correlate the placental shadow seen in the recumbent lateral abdominal films with the fetal displacement seen on the erect pelvic film.

Since the introduction of roentgenologic placental visualization, the authors have made it routine to discharge all patients admitted with antepartum hemorrhage who have radiologic evidence of a normally implanted placenta one week after cessation of hemorrhage, thus saving hospital beds. Just prior to discharge and *after* the roentgen examination, a speculum examination is undertaken to exclude bleeding from an extraplacental site such as might occur with a cervical polyp or carcinoma.

The authors feel that the use of contrast media, whether for amniography, cystography, or aortography, is unjustified in the investigation of antepartum hemorrhage.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

THE GENITOURINARY SYSTEM

Abdominal Aortography, with Special Reference to Kidney Diseases. Rolf Weyde. Radiol. clin. **23**: 313–325, November 1954. (In German)

The Importance of Serial Aortography for Demonstration of Blood Vessels in Pelvis and Kidney. K. E. Loose. Ibid., pp. 325–337. (In German)

The technics of aortography *via* direct aortic puncture and retrograde catheterization are described by Weyde. The procedure is indicated for the study of pathologic changes and anomalies of the abdominal vessels; study of the blood supply of the several organs and determination of their form, size, position and function; study of renal and extrarenal tumors, and demonstration of the extent of disease in a single kidney.

Cysts are detected by their avascularity. The vascular pattern in a renal tumor may indicate its malignant nature. There are several such patterns. Extreme vascularity with many irregular opacified tumor vessels leaves no doubt as to the diagnosis. The focus is sharply demarcated, often rounded and surrounded by a capsule. The medium passes rapidly through many arteriovenous communications and a little later the tumor bed is seen free of contrast material while the rest of the kidney still contains it. Other malignant tumors have a "washed-out" vascular appearance, and only a few malformed vessels are demonstrable. Still others show no contrast filling, though it is possible that even these would exhibit a vascular phase if studied by methods allowing multiple rapid exposures. Epithelial tumors arising in the kidney pelvis show no abnormal vascular pattern.

In Weyde's material of 32 malignant tumors, 25 showed vascular changes which alone were adequate to indicate malignancy. The diagnosis of cysts is on firmer ground, only 2 errors having occurred in a series of 19 cases.

Aortography is especially useful in hydronephrosis, furnishing information concerning the extrarenal vascular pattern and the condition of the kidney parenchyma, both anatomically and functionally.

In renal tuberculosis there is reduced vascularization of the involved portion of the parenchyma. The contrast-filled vessels have irregular contours, changing calibers, and sudden changes in course. A "washing-out" of the vascular pattern is seen on the nephrogram, corresponding to the tuberculous process. While the focus may be sharply delineated, this is usually not the case, partly because the process in itself is not sharply defined and partly because of superimposition of the vascular pattern of the normal kidney. It is emphasized that there is no specific vascular pattern of tuberculosis, since pyelonephritis may produce the same findings.

Weyde studied over 150 cases of renal tuberculosis, correlating his observations with urography, intravenous pyelography, and the surgical findings in 94. In only 1 case with a normal urogram was a positive aortogram obtained. In 35 of the 94 cases, aortography demonstrated a more extensive process than the urogram. In 41 cases, the aortogram was either negative or showed a focus the same size as the urogram. In 7 cases, the aortographic findings were not correct, showing a larger focus than seen in the specimen. This is due probably to the functional changes in the vascular structures in the healthy kidney near the unhealthy one. In 11 cases aortography was technically unsatisfactory.

Aortography should be considered only as a supplement to standard methods of examination. It can be of great value in surgical planning.

Weyde uses a film changer allowing six exposures per second. However, he emphasizes that aortography can be carried out effectively in routine practice without this special apparatus.

Loose, in a paper immediately following that of Weyde, discusses at length the importance of rapid serial aortography as opposed to a single exposure for the avoidance of serious errors of interpretation.

Weyde's paper contains 9 roentgenograms and a photograph of an operative specimen; Loose illustrates his paper with 16 roentgenograms and 1 photograph.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Renal Angiography in Cases of Delayed Excretion in Intravenous Urography. Hans Idbohrn. Acta radiol. **42**: 333–352, November 1954.

Renal angiography was performed on 22 patients in whom renal function, as judged by intravenous urography, had ceased or was poor on one side. In 19 of the 22 cases the results were directly comparable to the

findings on subsequent urography and operation. The width of the renal artery was in most cases a good guide in the evaluation of kidney function. However, considerable variations exist and overestimates or underestimates may be made. A more definite opinion as to the significance of the difference in size of the renal arteries requires a greater number of cases, so that the range of variation may be determined.

Thirty-three roentgenograms; 3 photographs; 2 tables.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

Venous Pooled Nephrograms: Technique and Results. John H. Detar and James A. Harris. J. Urol. **72**: 979–982, November 1954.

The authors describe a simple, safe, and effective method of nephrography involving pooling of the medium in the arm veins. Following application of a tourniquet high on the arm, 25 c.c. of 70 per cent Urokon is injected into a vein of the wrist or hand. The arm is then raised, the tourniquet is loosened, and nephrograms are obtained after fifteen and sixty seconds.

Of a series of 55 nephrographic studies by this method, 80 per cent were satisfactory, which compares favorably with the results of rapid injection technics. Reactions were infrequent and minimal.

Seven roentgenograms.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Calyceal Diverticula. Robert J. Banker and William H. Card. J. Urol. **72**: 773–776, November 1954.

In 2 patients with urinary symptoms a calyceal diverticulum was demonstrated by retrograde pyelography. In one the diverticulum was situated in the superior calyx of the right kidney, in the other in the middle minor calyx of the left kidney. Conservative surgical excision of the affected area resulted in rapid recovery in each instance.

Urographically the calyceal diverticulum is distinct from the collecting system of the involved kidney, being connected to it by a filiform channel which may or may not be demonstrated by excretory or retrograde examination. Commonly there is a relatively prolonged retention of contrast medium in the cavity after the remainder of the collecting system has completely emptied.

Four roentgenograms.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Triplicate Ureter. Herbert D. Axilrod. J. Urol. **72**: 799–801, November 1954.

Three types of triplicate ureter have been reported: (1) There may be complete triplication with three ureteral orifices. (2) One of duplicate ureters may be bifid, so that there are three ureters but only two ureteral orifices. (3) The ureter may be trifid, dividing above the bladder level and having a single orifice. A case of the second type is reported. Two similar examples were found in the literature. The author found, also, reports of 4 cases of complete triplication and 6 of trifid ureter.

One roentgenogram.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Diagnosis of Vaginal Ectopic Ureter by Vaginogram. Perry Katzen and Benjamin Trachtman. J. Urol. **72**: 808–811, November 1954.

Since an ectopic ureteral orifice in the vagina is often impossible to identify and there is usually no function in the corresponding segment of the kidney, a vaginogram may be the only means of demonstrating and localizing the anomalous ureter. Such a case in a 7-year-old girl is reported. With the patient in the Trendelenburg position and the vagina distended with 20 c.c. of 40 per cent Hippuran, the ectopic ureter was filled and identified. It was subsequently removed surgically.

Three roentgenograms.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

Vaso-Epididymography and Vasoseminal Vesiculography. Benjamin S. Abeshouse, Eugene Heller, and Julian O. Salik. J. Urol. **72**: 983–991, November 1954.

For vaso-epididymography and vasoseminal vesiculography the vas is exposed through the upper part of the scrotum and 1.0 c.c. of 70 per cent Urokon is injected by means of a No. 26 hypodermic needle toward the epididymis. The needle is then withdrawn and reinserted in the opposite direction and a second injection of 1.5 c.c. is made. The other vas is similarly exposed and injected. With the patient turned on his abdomen and non-screen film beneath the scrotum, an exposure of 1/4 second is made, with the x-ray tube at a distance of 36 inches, angled from 15 to 20 degrees (100 ma, 50 to 70 kv). Separate plain films of the bladder region are obtained.

Numerous representative cases are cited in which this procedure was employed. In acute and chronic epididymitis a "pooling" of the contrast material within the epididymis was observed. Similar findings were noted in a routine examination of a patient who had sustained a testicular injury many years previously. A vasoscrotal fistula with obstruction of the vas and a contraction of the seminal vesicle were demonstrated in a patient with tuberculous disease. A tumor of the testicle caused an extrinsic pressure deformity of the epididymis. Invasion of the seminal vesicles by prostatic carcinoma produced narrowing of the vesicle lumen. In a case of male sterility, information was obtained which suggested the feasibility of vaso-epididymostomy, and in a final instance (to be reported in full elsewhere) an ectopic ureteral opening in the right seminal vesicle was demonstrated.

The procedure is considered harmless. The mucosa of the vas is not altered, and its patency is not disturbed.

Twelve roentgenograms.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

THE ADRENALS

Adrenal Images Obtained with Retroperitoneal Insufflation and Operative Control. A. Lurà, G. Forni, and C. Biavati. Ann. di radiol. diag. **27**: 298–351, 1954. (In Italian)

The authors report on 300 studies of the adrenal region by retroperitoneal insufflation associated with stratigraphy and frequently with urography. Both normal and abnormal cases were included, and in 40

instances pathological findings were available for control of the roentgen observations. The following points are made:

Retroperitoneal insufflation changes the morphology and position (especially in respect to the kidney) of the normal adrenal glands. The phrenico-adrenal ligament is often well visualized in the normal state. At times stratigraphy in the upright position can clarify certain doubtful findings. In addition to deformities and changes in volume of the adrenals, the density of the images is important in the determination of abnormality. This is often better evaluated on the plain stratigraphic study before pneumoretroperitoneum. Calcification is also better demonstrated on such a study. A diagnosis of diminution of adrenal volume should be made with great caution. A homogeneous increase in density accompanied by increase in volume should be interpreted as pathologic, even if bilateral and not accompanied by definite changes in shape. Unilateral increase in size with deformity, especially if ball-shaped, is practically pathognomonic of an adrenal tumor. The tail of the pancreas at times may be confused with an adrenal tumor in retroperitoneal insufflation studies.

Among the abnormal cases, an adenoma of the adrenal in a patient with Buerger's disease was encountered. The authors believe that this might be a factor in the etiology of that disease.

Thirty-nine roentgenograms, with accompanying line drawings; 6 photographs.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

RADIOTHERAPY

Treatment of Hemangioma of the Skin in Infancy and Childhood by Roentgen Irradiation and Radium (A Report of 323 Cases). Anis Abdulkerim, Joseph A. Boyd, and Robert J. Reeves. Pediatrics **14**: 523–527, November 1954.

The authors classify hemangiomas on the basis of their relative sensitivity to irradiation. Those considered sensitive are cavernous, strawberry, and mixed cavernous and strawberry hemangiomas, bright red capillary and spider nevi. Port-wine stain, hemangioma simplex, and sclerosing hemangiomas are considered insensitive.

The authors have used roentgen irradiation, external radium, and occasionally interstitial radon in the treatment of these lesions. The factors of roentgen irradiation have for the most part been 100 kv, 4 cm. target-skin distance, and 0.5–1.0 mm. Al filtration, though 140 kv and 4 mm. Al filtration have occasionally been employed. Two hundred to 250 r have been given per treatment and the number of treatments has varied anywhere from one to five, given at six- to twelve-week intervals. The total dose has varied from 200 to 1,000 r. For radium treatment, platinum-filtered plaques or linear sources have been used on the skin or at 1 cm. distance, 350 gamma r being given at one sitting and repeated in six to twelve weeks. Not more than five treatments have been given to a single lesion, either with radium or roentgen irradiation. Both have been employed on some lesions. Radium is said to be easier to use in infants. Roentgen irradiation is less time-consuming and the results are felt to be comparable.

Of 323 patients, 11 had one treatment, 55 had two treatments, 74 had three treatments, 63 had four treatments, and 120 had five treatments. The follow-up period in these patients has extended from nine months to twenty years. In most instances more than one year has been required for a satisfactory result, and the longer the period of follow-up, the higher has been the percentage of such results. Complete failure was experienced in 3 to 5 per cent of the cases, with a somewhat higher percentage of failure in those lesions on which roentgen irradiation alone was used. Of 7 port-wine stains treated, only 1 showed improvement, but there was latent skin damage in this patient. It is felt that results are generally poor in adults.

While in this group of patients a higher percentage of satisfactory results was achieved with radium therapy alone as compared with roentgen irradiation alone (82 per cent as opposed to 58 per cent), the radium-treated group was larger, with a longer follow-up, and it is the opinion of the authors that the two methods are equally effective.

With careful treatment, no serious sequelae are noted, though skin atrophy, telangiectasia, alopecia, and epiphyseal retardation are possible complications. It is advised that not more than 500 gamma roentgen be given over an epiphysis. Cataracts, glaucoma, and iridocyclitis have also been reported as complications. In this series of 323 patients, scarring occurred in 18, telangiectasia in 4, shortening of the treated leg in 1, and enlargement of the treated breast in 1. In 4 cases new hemangiomas developed. Ten patients required surgery for cosmetic reasons or failure of irradiation and 2 had associated intracranial aneurysm.

Four tables. H. G. PETERSON, JR., M.D.
New Britain, Conn.

Massive Preoperative Irradiation in the Treatment of Osteogenic Sarcoma in Children. A Preliminary Report. Kenneth C. Francis, Ralph Phillips, James J. Nickson, Helen Q. Woodard, Norman L. Higinbotham, and Bradley L. Coley. Am. J. Roentgenol. **72**: 813–818, November 1954.

Previously published information is cited suggesting that preoperative irradiation of osteogenic sarcoma improves the overall results. The authors' series consists of 15 children with histologically proved osteogenic sarcomas arising in the lower extremity. None of the group presented radiological or clinical evidence of metastatic disease at the time treatment was instituted. Each patient received massive irradiation of the tumor area to a calculated tissue dose of between 6,000 and 12,000 r delivered in a total treatment time of five to thirteen days. Supervoltage radiation, h.v.l. 3.8 mm. Pb, was used. Each tumor was treated through two opposing portals and the margins of the treatment fields were carefully marked on the child's skin. One to three days following completion of irradiation, the limb was amputated above the highest level of the treatment field.

No serious side-effects from the irradiation *per se* were noted in any of the patients. In some cases, demonstrable decrease in serum alkaline phosphatase levels was recorded, and in some tumor alkaline phosphatase showed slight increase.

Of 10 patients treated during the first year of this regimen, only 3 survived as long as one year. The 5 patients treated during the second year of the trial course were still living without apparent disease at the time of the report. The length of follow-up, however, was less than one year. The authors feel that thus far the results have not been encouraging but plan to continue the study and to pursue a longer period of observation.

J. W. BARBER, M.D.
Cheyenne, Wyo.

The Results of Radiation Therapy of Carcinoma of the Cervix at the First Gynecological Clinic of the University of Munich in the Years 1947 and 1948. Heinrich Eymer and Julius Ries. Strahlentherapie **95**: 367–369, November 1954. (In German)

Of 531 patients with carcinoma of the cervix seen in the year 1947 and treated exclusively with radiation therapy, 230 (46.3 per cent) were living and free of recurrence after five years. The five-year cure rates were as follows: Stage I, 42/62, or 67.7 per cent; Stage II, 96/168, or 57.1 per cent; Stage III, 106/273, or 39.4 per cent; Stage IV, 2/28, or 7.1 per cent.

Of the 476 patients with carcinoma of the cervix seen in the year 1948, 239 (50.2 per cent) were living and free of recurrence after five years. The 5-year cure rates for this group were: Stage I, 53/69, or 76.8 per cent; Stage II, 87/132, or 65.8 per cent; Stage III, 98/252, or 39.5 per cent; Stage IV, 1/23, or 4.5 per cent.

One table, showing the results of therapy in successive years from 1940 through 1948.

ULRICH K. HENSCHKE, M.D.
Ohio State University

Energy Distribution in the Thorax During Multiple Field and Rotational Therapy. Joseph R. Nahon and John B. Hawkes. Am. J. Roentgenol. **72**: 819–825, November 1954.

A plywood phantom of 0.5 density is shown experimentally to give a close approximation of roentgen ray absorption in the human thorax. (The density of lung tissue in contrast to unit density of solid parts of the body has been variously estimated as 0.2 to 0.78.) The authors calculated doses at selected points within the phantom, using rotational and multiple-port technics. Measured points corresponded to the mid-mediastinum, the center of each lung, a point near the periphery of each lung, and a theoretical tumor site at approximately the hilar region. The resulting calculated doses demonstrate that the normal lung tissue adjacent to the tumor must receive a high dose of radiation when either rotational therapy or multiple small portals completely encircling the chest are utilized. The dose in the ipsilateral lung approaches closely that at the theoretical tumor site, while the dose in the contralateral lung is about 1/3 to 1/2 as high. With a unilateral multiple-port technic, treating only one side of the chest, the mid-lung tissue of the treated side received a dose slightly higher than the centered tumor point, but the contralateral lung was spared greatly.

Several small drawings show calculated isodose curves demonstrating various rotational and multiple-port set-ups.

Two roentgenograms; 2 photographs.

J. W. BARBER, M.D.
Cheyenne, Wyo.

Roentgen Dose Measurements on a Radiation of Very High Intensity. Bo Lindell. Acta radiol. **42**: 398–410, November 1954.

The author gives a survey of the possibilities of determining the ionization losses caused by ion recombination in thimble chambers irradiated with roentgen rays of very high intensity. Dose measurements were made, and saturation curves are shown illustrating the performance of two common types of chambers irradiated with short roentgen pulses from the discharge tube earlier described by Sievert (Acta radiol. **33**: 328, 1950. Abst. in Radiology **57**: 473, 1951). In a small volume it is possible to deliver with this tube roentgen doses up to 1,000 r, at rates up to 10^9 r/sec, the pulse duration being shorter than 100 microseconds. It is shown that, even at these high dose rates, the saturation in the chambers can easily be determined by help of the common formulae used at moderate dose rates. A method is suggested for calculating the real dose when the rate is not known sufficiently well to permit a direct estimation of the correction that should be applied to the measured values because of the ion recombination.

Four figures.

Radical Surgery After Intensive Irradiation. Harry L. Berman. Arch. Surg. **69**: 603–606, November 1954.

The present trend toward radical surgery after intensive radiation therapy for cancer, to extirpate recurrent or residual disease, is a worthy effort but, since risk is involved from the standpoint of postoperative morbidity, the author considers it well to attempt to set up favorable and unfavorable criteria for post-irradiation surgery.

The tissue effects of irradiation are influenced in part by physical factors of equipment, as voltage, filtration of the x-ray beam, distance of external source of irradiation, total dose and elapsed time of its delivery, and the size and number of the treatment fields. The response is also affected by certain characteristics of the tissue irradiated, such as its inherent sensitivity and tolerance, the presence or absence of infection, and alterations of normal blood supply.

One way of measuring tissue effect is to observe the evolution and resolution of the skin erythema developing in the treatment field. Thus irradiation of an abdominal field 10 × 10 cm. with a skin dose of 3,000 r over a ten-day period, delivered by a 250-kv machine, with a half-value layer of 1.5 copper, will cause an erythema in about seven days with vesiculation during the next two weeks. This will subside and disappear during the next two to four weeks, with a residual soft scar and ultimately some atrophy and telangiectasia. If this dosage were protracted over thirty days, the erythema would be less severe and healing would likely occur without sequelae. If supervoltage were used under the same conditions, the skin reaction would be considerably less.

The reaction in the underlying tissues parallels that in the skin, with the exception that each abdominal viscus exhibits a specific susceptibility. Thus the maximum reasonable permissible dose to intestine, gallbladder, spinal cord, and urinary bladder is 4,000 r in thirty-five days, with the quality of irradiation referred to above.

The favorable criteria for surgery in previously irradiated tissues include relatively small doses of radiation, small treatment fields, a reasonably long

period of time between completion of irradiation and the date of operation, and employment of higher voltages. Before surgery is performed, the ability of the irradiated tissue to tolerate further trauma should be determined. In this connection it must be emphasized that, when the combined form of treatment is used, postoperative inflammatory changes due to infection and/or other causes may still occur, just as in non-irradiated tissue. Previously irradiated tissue does not invariably constitute a site of diminished resistance, and the assumption that irradiation is primarily responsible for all untoward complications after surgery is unwarranted, especially in the light of our limited knowledge about failures of wound healing.

At times irradiation may make surgery more feasible by causing partial shrinkage of a tumor and reducing its vascularity. The combined procedure, however, is one of formidable proportions and can be expected to have some undesirable complications, the assessment of which requires a critical evaluation on an objective plane.

F. F. RUZICKA, JR., M.D.
St. Vincent's Hospital, N. Y.

McWhirter Technique for Treatment of Breast Cancer. An Appraisal. Vincent P. Collins. Texas State J. Med. **50**: 752–754, November 1954.

The author quotes figures which indicate that survival rates of patients treated by simple mastectomy and radiotherapy, as advocated by McWhirter, compare favorably with those from radical mastectomy. The absolute survival rate is preferred for comparing the effects of treatment in different institutions rather than the results of a single form of treatment, which are necessarily influenced by varying criteria for selection from one center to another.

Three groupings are suggested for classification of any unselected series of breast cancer:

Group A, disease confined to the breast. For these patients cure should be possible either by simple or by radical mastectomy.

Group B, metastatic extension limited to the accessible axillary lymph nodes.

Group C, more distant spread of disease. In this group cure by any method of treatment would not be a reasonable goal.

If there is any difference in the adequacy of surgical dissection and radiation in the treatment of axillary metastases, it is the survival of patients in Group B that would be influenced by the choice of treatment. Since survival rates under the two treatment programs do not show a significant difference, one might conclude that either the methods are equally effective, or Group B is so small that any difference in effectiveness is not evident in overall survival. Actually the incidence of metastases in the supraclavicular and internal mammary regions may be considerably higher than has previously been suspected, and Group B may therefore be quite small. Whenever axillary lymph nodes are positive for metastatic cancer, there is a high likelihood of more distant spread of disease.

It is concluded that the outcome for a given patient with cancer of the breast, in terms of survival, depends more on the extent of the disease at the time the treatment is given than upon the treatment itself. Although radical mastectomy is still the accepted method for favorable cases of cancer of the breast, further application of simple mastectomy and radiation is advocated in less favorable cases in an effort to adjudge the ultimate role of the McWhirter approach to treatment.

[This paper, as its title indicates, is simply an appraisal. No new material is presented. For Professor McWhirter's own experience with simple mastectomy and radiotherapy, see Brit. J. Radiol. **28**: 128–139, March 1955. An editorial comment on the procedure appears in Radiology **65**: 111–112, July 1955.]

Two tables.

ARTHUR S. TUCKER, M.D.
Cleveland Clinic

Radiation Therapy in Management of the Lymphomas. Simeon T. Cantril. Texas State J. Med. **50**: 755–766, November 1954.

The author discusses his experience with the management of lymphomas at the Tumor Institute of the Swedish Hospital, Seattle. He includes discussions of Hodgkin's disease, lymphosarcoma, and giant-follicle lymphoma.

Hodgkin's disease is preferably treated by roentgen therapy, especially that minority of cases in which the initial manifestation of the disease is lymphadenopathy limited to a single regional group of nodes. The aim is to give sufficient irradiation to produce permanent arrest of the local process, which means a minimum of 3,500 r to the tumor in three to four weeks. Because of the unpredictability of the disease, local areas of involvement may be given larger doses. Due attention is directed to maintaining the general condition of the patient. Of the agents used in the chemotherapy of Hodgkin's disease, the author prefers nitrogen mustard, administered intravenously, particularly in cases presenting fever, itching, or anemia, or when irradiation no longer is applicable. He believes, however, that the responsiveness of Hodgkin's disease to nitrogen mustard, in general, is of shorter duration than to adequate irradiation.

When many areas of lymphadenopathy are present, treatment is usually limited to those producing symptoms. Visceral involvement as a rule connotes a poor prognosis, but good palliation has been achieved by irradiating lesions in the bones, mediastinum, and gastrointestinal tract. Attempts to control pulmonary infiltration of Hodgkin's disease have been unsuccessful.

Lymphosarcoma is perhaps even more capable than Hodgkin's disease of involving any or all tissues and thus producing clinical manifestations of all degrees of complexity. Certain forms are relatively benign, as in the parotid and lacrimal glands or the skin. Although lymphosarcomas in children usually run a fulminating course, a case of seven-year survival is reported following resection of an ileocecal lymphosarcoma at the age of seven (no irradiation was administered). Lymphosarcomas of the tonsil and nasopharynx have been irradiated vigorously, to the point of complete regression of the lymphatic masses, but never without ultimate development of fatal visceral lymphosarcoma. The volume of tissue irradiated in lymphosarcomas is in general as large as can be tolerated, and the minimum dosage is 2,400 to 3,000 r to the tumor in three to four weeks.

Giant-follicle lymphoma, by contrast, runs a relatively benign natural course and is highly susceptible

to external irradiation in minimal dosage. Irradiation is reserved for sites requiring relief from symptoms and is given in doses not exceeding 1,000 to 1,500 r. As in lymphosarcoma—but to a greater degree—certain of the patients ultimately develop leukemia.

Twenty-eight roentgenograms; 1 photograph.

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RADIOISOTOPES

Quantitative Measurements of Radioiodine Retention in Thyroid Carcinoma. E. Eric Pochin, R. M. Cunningham, and Gwen Hilton. J. Clin. Endocrinol. & Metab. **14**: 1300–1308, November 1954.

The authors have attempted (1) to find how the degree of radioiodine retention changes from dose to dose in cases of functioning thyroid carcinoma and whether this offers a criterion as to the progress of treatment; (2) to determine the speed of radioiodine turnover in these tumors, since this is relevant to the amount of radiation delivered by each dose. They describe their method of obtaining a "profile" curve indicating the distribution of the isotope along the length of the body.

Measurements indicated that, in patients with clearly functioning tumors examined after thyroid ablation, the total tumor uptake commonly falls progressively from dose to dose and the uptake of any one dose is usually between 30 and 80 per cent of that of the preceding dose. Though the subject requires further investigation, it is stated provisionally that "a progressive fall in total tumor radioiodine uptake from doses at six-week intervals or more seems worth considering as an indication of a corresponding destruction of tumor tissue."

The daily rate of discharge of radioiodine from the tumor tissue, determined on successive days after treatment, was found, in the series studied, to average about 20 per cent of the tumor content, varying from 10 to 40 per cent per day in individual cases. This rapid turnover does not appear to be due to intense stimulation by the thyroid-stimulating hormone (TSH) since, if thyroxine treatment is instituted twenty-four hours after the administration of radioiodine, when tumor uptake is complete, the rate of discharge is not reduced in the ensuing week. The same was thought to be true of triiodothyronine. The discharge rate is also uninfluenced if an attempt is made to suppress the endogenous TSH entirely by maintaining the patient on thyroxine before and after the radioiodine dose.

The rapid turnover of the radioiodine may well, therefore, be the property of the tumor tissue rather than any effect of its stimulation. This is held to be likely for two further reasons. (1) The follicles of differentiated thyroid carcinoma are of small size and it has been shown that in the smaller follicles, both in human and rat thyroids, there is more rapid turnover of iodine than in the larger follicles. This may be a simple consequence of the higher ratio of cell mass to colloid mass in the small follicles. (2) In normal thyroid tissue, radioiodine passes rapidly from the cells to the colloid so that, in effect, the cells are the medium for uptake and the follicles for retention of radioiodine. For these reasons, tumors consisting mainly of functioning cells which are not arranged in follicles might take up radioiodine but discharge it as rapidly as has been shown to occur.

Seven graphs.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Uptake of Radioactive Iodine in the Thyroid of Patients with Impaired Liver Function. Richard Mueller, Charles C. Brausch, Eugene Z. Hirsch, Richard S. Benua, and Brown M. Dobyns. J. Clin. Endocrinol. & Metab. **14**: 1287–1299, November 1954.

This is a detailed paper giving ample substantiation of the fact that hepatic insufficiency influences the thyroidal uptake of radioactive iodine. Of 50 patients with liver disease but no evidence of thyroid disturbance, 20 had an uptake of 50 per cent or higher. This high thyroidal uptake was associated most frequently with spider angiomata, jaundice, and microscopic evidence of severe cellular damage to the liver. No direct correlation was established with the presence of ascites or the results of any single test for liver function.

In spite of the increased uptake in the presence of liver disease, no evidence of increased production of thyroid hormone could be discovered either clinically or by laboratory determinations of the basal metabolic rate, the serum protein-bound level, or the height of the thyroid cells. Tests of kidney function in sample patients appeared to rule out possible renal disturbance as a cause of the elevated thyroidal uptake.

It is concluded that mechanisms other than those in the thyroid are the primary cause for the high iodine uptake in patients with liver disease, though no strong clue to the mechanism was discovered in this study. It merely indicates that a high uptake does occur and may be misleading in patients with liver disease whose symptoms might require the exclusion of thyrotoxicosis.

Five figures; 4 tables.

SYDNEY F. THOMAS, M.D.
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Method for Increasing the Accuracy of the Radioiodine Uptake as a Test for Thyroid Function by the Use of Desiccated Thyroid. Monte A. Greer and G. Edward Smith. J. Clin. Endocrinol. & Metab. **14**: 1374–1384, November 1954.

In euthyroid persons and patients with simple goiter, the daily administration of physiologic amounts of desiccated thyroid resulted in a suppression of thyroidal radioiodine metabolism to myxedema levels. In thyrotoxic patients, much larger amounts of exogenous thyroid were required for any appreciable suppression of radioiodine metabolism. This observation suggests that the administration of desiccated thyroid may prove a useful means of increasing the accuracy of diagnosis in patients in whom the results of radioiodine uptake studies are equivocal.

The authors' observations were made on 28 patients with thyrotoxicosis and 55 euthyroid patients. Almost without exception, goitrous and non-goitrous euthyroid patients showed a suppression of the 24-hour thyroidal radioiodine accumulation below 20 per cent following the administration of 540 mg. of desiccated thyroid daily for one or two weeks; in fact, the uptakes of most of these patients were suppressed below 20 per cent by only 180 mg. daily. In none of the thyrotoxic

patients was suppression below 20 per cent induced by a dosage of 540 mg. daily, and in only 1 was such suppression induced by 720 mg. daily.

Four graphs.

SYDNEY F. THOMAS, M.D.
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The Distribution of Radioiodine Observed in Thyroid Disease by Means of Geiger Counters—Its Determination and Significance. J. P. Nicholson, C. W. Wilson, and K. A. Newton. Am. J. Roentgenol. **72:** 849–856, November 1954.

The authors investigated counting properties of three types of Geiger counter chambers and collimators with various I^{131} sources. Point sources, volume sources, and lesions within patients were counted. It is concluded that the "wide-aperture" counter chamber with proper lead shielding for maximum collimation is the most practical of the three instruments tested. This consists of a lead shield 1.0 cm. thick having an aperture 2.5 cm. in diameter, the full aperture of the counter (a G.E.C. copper-walled end-window G.M.4 counter).

Isocount-rate contours are shown for various sources. The observations indicate that caution must be used in deducing actual shapes of radioactive sources from such contours even though the size may be roughly estimated.

Clinical studies were made with the wide-aperture counter and it is shown that a rough idea of the geometry of functioning tissue within a patient can thus be determined. Two cases are reported in which useful information was obtained.

Seven illustrations.

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Use of P^{32} as an Aid in Diagnosis of Intraocular Neoplasms. Further Observations. I. J. Eisenberg, I. S. Terner, and I. H. Leopold. Arch. Ophth. **52:** 741–750, November 1954.

In a previous article (Arch. Ophth. **51:** 633, 1954. Abst. in Radiology **64:** 631, 1955) a test using radiophosphorus for the detection of intraocular neoplasms was described. This consisted in the injection of 500 μc of P^{32} intravenously, and one hour later taking counts at the limbus of the normal eye in positions 12, 3, 6, and 9 o'clock and directly over the area of involvement in the affected eye. [In the earlier paper the dose was stated to be 500 mc, presumably in error.] The test has now been modified and counts are taken one and twenty-four hours after the injection of P^{32}. One hundred twenty-three cases (26 intraocular neoplasms, 34 serous retinal displacement, 12 cataract, 17 glaucoma, 10 intraocular hemorrhage, 13 inflammatory retinal detachment, 5 inflammatory lesions without detachment, 6 iris lesions) have been studied with the modified procedure. The authors' conclusions are as follows:

The test is limited in its use to (*a*) subjects with one eye or with bilateral ocular disease, (*b*) lesions in the posterior segment of the globe, and (*c*) tumors in the less active metabolic state.

The P^{32} test is positive for a malignant lesion if (*a*) in one hour the uptake is 30 per cent or more greater than the average in the normal eye and (*b*) the twenty-four-hour uptake shows a percentage increase greater than the one-hour uptake.

A negative test indicated a non-malignant lesion in approximately 95 per cent of the cases studied. The test, however, was decidedly reduced in accuracy in retinoblastomas in children.

A positive test was strongly suggestive of a malignant neoplasm in all of the eyes studied.

Seven figures.

Studies on the Excretion of Chloride by Man With and Without Congestive Heart Failure, Using Long-Life Radiochloride, Cl^{36}. C. T. Ray, S. A. Threefoot, and G. E. Burch. J. Lab. & Clin. Med. **44:** 663–701, November 1954.

The excretion patterns of Cl^{36} were studied in 6 subjects (2 controls, 4 patients with congestive heart failure) immediately following and for prolonged periods (thirty to seventy days) after a single rapid intravenous administration of 50 μc of the tracer. The concentration of Cl^{36}, sodium, and potassium was determined in the serum, urine, and other biologic fluids, and the volume of urinary output recorded. The stools were assayed only for Cl^{36} excretion.

The time of appearance of Cl^{36} in the urine following intravenous injection varied from two to seven minutes in 5 subjects (in the other the concentration was so low that it was impossible to measure significant quantities of tracer). The rate of urinary excretion of chloride during the first ninety minutes was much less for the patients with congestive heart failure than for the controls. There was an inverse relationship between the rate of excretion and the body weight of the patient, the relationship being different for the subjects with severe congestive heart failure than for the controls and subjects with mild or moderate congestive failure.

From 95 to 99 per cent of the injected tracer was recovered from 3 subjects who were studied for seventy days. This is significant in determining the quantity of radiation to the tissues of man from Cl^{36}.

Patterns of daily excretion of Cl^{36} in the urine and stool indicate that variations in excretion of chloride may be produced by changes in the intake of the electrolyte, administration of sodium bicarbonate, mercurial diuretics, and other drugs, or changes in the physiologic state. Patients with congestive heart failure manifested a greater excretion of chloride after mercurial diuretics and maintained this increased rate of excretion longer than the control subjects, who showed a "rebound" retention of Cl^{36} and Cl^{35} the day following the administration of the diuretic. On both low and high chloride diets, the controls excreted more chloride than the subjects with congestive heart failure except when the latter were in the process of compensation or massive diuresis initiated by either therapeutic or spontaneous factors.

Certain discrepancies were observed between the rates of excretion of Cl^{36} and Cl^{35} and also between the specific activity of chloride in the urine and serum. These discrepancies are related to the physiologic phenomena of lags of rate of exchange and sequestration of chloride.

Clearance rates of sodium and potassium, even when corrected for differences in intake and serum concentration, were not equal to the urinary clearance of chloride. A notable discrepancy was obtained during ammonium chloride administration. The corrected sodium clearance exceeded that of chloride, indicating that relative to dietary intake a greater amount of sodium is being

excreted. During sodium bicarbonate administration the same pattern was present because of increased sodium excretion and decreased chloride excretion.

The daily balance data for chloride, sodium, and potassium showed the patterns to conform to the observations concerning the excretory rates.

Seventeen figures.

Experimental Effects of Radioactive Colloidal Gold in the Subarachnoid Space. Clinical Application in Treating Brain Tumors. Fred W. L. Kerr, Henry G. Schwartz, and William B. Seaman. Arch. Surg. **69**: 694–706, November 1954.

A study was undertaken to investigate the possibility of introducing radioactive colloidal gold into the subarachnoid space to irradiate free floating tumor cells and small implants such as may occur with medulloblastomas and ependymomas. Gold was considered suitable for this purpose because of its availability, its short half-life, and lack of diffusibility. Its beta emission penetrates up to 3 mm. in tissue, with 90 per cent absorbed in the first millimeter.

A colloidal suspension of Au^{198} in weak aqueous gelatin was used. Preliminary experiments indicated that the particle size was too small to produce obstruction or hydrocephalus.

Eleven dogs and 2 rabbits were used in the animal experiments. The injections were made by cisternal puncture under Nembutal anesthesia. To determine the distribution of gold along the cerebrospinal axis, two methods were employed: (1) radioautography using 50-μ frozen sections on film in the darkroom and (2) absolute measurements of radioactivity in terms of millicuries. The neuraxis and viscera were divided into various anatomic segments. Each segment was counted with a scintillation counter and compared to a standard of the original injected solution. Finally, microscopic sections of the neuraxis were made.

Administration of 30 millicuries or more (in a 2 c.c. volume) resulted in severe symptoms. In 2 dogs, respiratory death occurred shortly after injection. With doses of 12 to 30 millicuries in volumes of 0.5 to 1.0 c.c., neuritis, ataxia, or meningeal signs occurred in forty-eight hours. Signs of neurological deficit were generally progressive. Doses of 11.5 millicuries or less produced no clinical symptoms in 4 dogs, 2 of which were entirely normal six and fifteen months after injection.

After doses of 30 millicuries, sections of the medulla showed necrosis and hemorrhage in the dorsal aspect for a depth of 2 mm. Histologic signs of damage to the cord and meninges were found to be almost directly proportional to radiation dosage. One month after injection of 15 millicuries, sections from one of the dogs showed edema of the leptomeninges with lymphocytic infiltration and damage to the cord itself. Sections from another animal five months after introduction of 10 millicuries disclosed very slight edema of the superficial portions of the dorsolateral aspect of the cord and minimal thickening of the arachnoid. The nerve roots were intact.

Radioautographs made at various levels following administration of 11.5 millicuries indicated that the material reaches the depth of the sulci of the cerebral hemispheres and cerebellum, as well as the most caudal portion of the cord. No radioactivity could be demonstrated in the walls of the lateral or third ventricles. With the scintillation counter it is evident that, when thorough mixing is effected, the distribution is fairly uniform. In an animal killed four days after relatively even distribution was obtained, 83 per cent of radioactive material was still present in the central nervous system, while 17 per cent had escaped to the viscera and skull. The blood stream and urine showed patterns of radioactivity. After cisternal puncture, the colloid tended to adhere to the walls of the subarachnoid space. In twenty-four hours there was very little activity in the spinal fluid, although there was persistent intense activity over the neuraxis.

Clinical trial was made in 11 selected patients with hopeless malignant tumors—1 meningeal sarcoma, 3 primary sarcomas of the cerebellum, 3 ependymomas, and 4 medulloblastomas. Total dosages ranged from 5 to 27 millicuries, without evidence of untoward effects. Not more than 10 millicuries was given in any one dose. Ten to fourteen days is considered an adequate interval between injections. The cases of medulloblastoma appeared to respond best. None of the patients treated suffered any detectable ill effects.

At present the authors recommend x-ray treatment of the primary lesion, with utilization of intrathecal radioactive gold to irradiate free floating tumor cells and small implants in the subarachnoid space.

Four autoradiographs; 6 photomicrographs; 5 tables.

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RADIATION EFFECTS; EXPERIMENTAL STUDIES

The Effect of Cortate and of Dramamine on a Selected Group of Patients Undergoing Deep Roentgen Therapy for Carcinoma of the Cervix Uteri. E. C. Lasser and K. W. Stenstrom. Am. J. Roentgenol. **72**: 827–837, November 1954.

A series of 50 patients undergoing closely similar courses of roentgen therapy for carcinoma of the cervix uteri form the basis of this study of radiation effects. Thirty patients served as a control group; 15 received Dramamine, and 15 Cortate (desoxycorticosterone acetate). Dramamine was given in 50-mg. oral doses three times daily on the tenth through the thirteenth day of irradiation and again on the twenty-first and twenty-second days. Cortate was administered in 5-mg. doses intramuscularly, once daily on each of the days noted above.

In a previous study (Am. J. Roentgenol. **72**: 474, 1954. Abst. in Radiology **65**: 154, 1955), the authors had found that symptoms of radiation sickness, absolute eosinophil levels, and adrenal reserve as measured by the Thorne test all varied from day to day during a course of radiotherapy. These same three factors were evaluated in the current study. The patient groups were further subdivided into premenopausal and postmenopausal women.

It was found that Dramamine had little or no effect on any of the three factors studied. Cortate produced a less steep fall in adrenal cortex reserve as measured by the Thorne test. The most important finding was definite decrease in the "symptom index" (summated symptoms of radiation sickness) in those patients on Cortate medication. It appeared that premenopausal

women responded somewhat better in general than postmenopausal.

All of the data are succinctly presented in table and graph form.

Nine graphs; 9 charts.

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Cheyenne, Wyo.

The Combined Effects of Thermal Burns and Whole-Body X-Irradiation. II. Anemia. A. K. Davis, E. L. Alpen, and G. E. Sheline. Ann. Surg. **140**: 726–735, November 1954.

Rats were exposed to ionizing radiation and to radiant thermal energy in varying doses in order to evaluate the nature and degree of damage from different combinations. It had previously been shown that the burned area required to kill 50 per cent of rats is reduced by non-lethal amounts of radiation (Ann. Surg. **140**: 113, 1954. Abst. in Radiology **64**: 795, 1955).

The rats were treated in the following groups: *C*, control; $X_{\frac{1}{2}}$, 500 r total-body x-irradiation; X_1, 100 r total-body x-irradiation; B_4X_1, four strip burns plus 100 r; $B_2X_{\frac{1}{2}}$, two strip burns plus 500 r; B_2, two strip burns; B_4, four strip burns. The two strip burns gave mean burned areas constituting 15 per cent of the total body area. The four strip burns gave mean burned areas of 25 per cent of the total body area. Other rats given a 25 per cent burn and a maximal sublethal dose of radiation almost invariably died within fifteen days.

The burns, whether including 15 or 25 per cent of the body area, produced an initial decrease in blood, plasma, and red cell volume, followed by rapid recovery of the red cell volume and prolonged elevation of the blood and plasma volume, with a concomitant reticulocytosis. Although red cell volume was not appreciably altered after the fifth day, a slight reduction in hematocrit, hemoglobin, and red count was observed over the thirty-day period of study.

Radiation in doses of 100 r produced only a transient depression of the reticulocyte levels. However, a severe anemia resulted from doses of 500 r. The fall in red cell volume was more rapid in $B_2X_{\frac{1}{2}}$ rats than in the $X_{\frac{1}{2}}$. The anemia of the combined-injury series was detectable on Day 8, and on Day 11 was equal to the maximum observed in the irradiated animals on Day 15. The authors postulate that an abnormal fragility of the red cells produces an increased loss of erythrocytes, which is a factor in the elevated death rate observed in the rats subjected both to burns and to irradiation.

The erythrocyte levels in the B_4X_1 rats more closely approximated the values of the burned than of the X_1 rats. The reticulocyte count proved to be the only useful indicator of exposure to ionizing radiation in this low dosage. Even the fall in this variable was obscured by the fifth day in the reticulocytosis characteristic of the burned rat. The $B_2X_{\frac{1}{2}}$ rats displayed hematopoietic changes closely related to those observed in the $X_{\frac{1}{2}}$ rats.

Three figures; 4 tables.

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Spleen Desoxyribonucleic Acid Content as an Index of Recovery in X-Radiated Mice Treated with Spleen Homogenate. Leonard J. Cole and Marie Ellis. Cancer Res. **14**: 738–744, November 1954.

The time course of total DNA (desoxyribonucleic acid)/spleen and spleen DNA concentration in LAF_1 mice following whole-body exposure to 740 r x-rays (an LD 100 dose) and the effect of spleen homogenate treatment on this end-point were studied. At twenty-four hours following irradiation, the DNA content of the spleen decreased from a normal value of 1,963 ± 70 μg. to 463 μg. After three days the DNA level had declined further to 229 μg., and this low level persisted in the control irradiated mice until death (ninth day). DNA concentration was likewise depressed from normal values of 19.7 ± 0.35 μg./mg. to levels of 8 μg./mg. until death.

A single postirradiation injection of spleen homogenate into the irradiated mice elicited a profound regeneration of the spleen in terms of DNA content, concomitant with survival of these animals. The recovery phenomenon was characterized by reversal of the depression in total DNA content of the spleen, which was, however, not manifest until the sixth day; by the ninth day the total DNA values exceeded those of normal mice. Further evidence for the relationship between spleen DNA content and recovery was provided by DNA analyses on splenectomized mice which had received spleen homogenate treatment.

The magnitude of the response in DNA content of the spleen, both during involution and in the recovery phase, was greater by factors of 2 and 3, respectively, than the spleen weight response. Recovery of the spleen DNA in x-irradiated mice receiving spleen homogenate precedes that of peripheral leukocyte count and body weight loss. The results indicate that the DNA level of the spleen provides a sensitive biochemical index of recovery following irradiation exposure. It is suggested that this end-point be employed as a biochemical assay for the spleen radiation protection factor.

Four charts; 2 tables.

Study of the Effect of High Temperature by Hot Baths, Short Waves and Ultrasonics on Cancer Tissue and Biological Principles of Combined X-ray-Ultrasonics Therapy of Superficial Tumors. Karlheinz Woeber. Strahlentherapie **95**: 333–366, November 1954. (In German)

The author describes the immediate histologic changes in transplanted Walker carcinoma of the white rat after baths at 40°C., short-wave treatment, and exposure to ultrasonic waves. While various abnormalities of mitosis were observed, a consistent regression of tumors was not accomplished. When roentgen treatment was combined with ultrasonic irradiation, only 350 r were necessary to bring about tumor regression. For the same result with x-rays alone, 600 r were required.

Twenty-one illustrations; 9 tables.

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